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Essays in Microeconomic Theory

A dissertation submitted in partial satisfaction of the
requirements for the degree
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in

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by

Charles Lin

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Professor On Amir
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Professor Joel Watson

2014

The dissertation of Charles Lin is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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ABSTRACT OF THE DISSERTATION

Essays in Microeconomic Theory

by

Charles Lin

Doctor of Philosophy in Economics

University of California, San Diego, 2014

Professor Syed Nageeb Ali, Chair

In the first chapter, we examine the tradeoffs that news organizations face between speed and accuracy in information provision. Journalists complain that the quality of news coverage is declining because of tradeoffs they face between speed and accuracy. We examine this tradeoff in a model where two players value being accurate, but also value being the first to report. Although delay allows players to improve the accuracy of their reports, we characterize equilibria and provide conditions for when competitive preemption concerns cause players to report without evidence. We explore the impact of competition on the quality of information provided, and consider the effectiveness of waiting periods in improving outcomes.

The second chapter presents a model where a firm attempts to persuade a customer to purchase a product by committing to a message strategy, but does

not know the customer's beliefs about the product's quality. We examine three contracting settings - firms can attach transfers to signals, purely wasteful costs, or condition transfers on the customer's purchase decision. We show that the optimal mechanism in each setting never provides information for free, and that customers with extreme beliefs are effectively denied any useful information.

The third chapter presents a model of voter turnout, where some individuals vote because they are motivated by a civic duty to do so while others may vote because they wish to appear pro-social to others. It proposes a simple framework that captures these motivations, and provides results consistent with findings on turnout, e.g. that turnout is responsive to the expected closeness and importance of an election, to the observability of one's choice to vote, and to social rewards and punishments associated with voting. We study various extensions of this framework in which community monitoring plays a role, and explore the implications that voter mobilization has for electoral competition.

Chapter 1

Speed Versus Accuracy in the News

1.1 Introduction

On June 28, 2012, the U.S. Supreme Court announced its ruling on the Affordable Care Act, a health care law that expanded health care coverage and subsidies in the United States. Only one minute after the ruling was released, CNN and Fox News incorrectly reported that the law had been struck down, and that it did not survive as a mandate. Immediately afterwards, cable news, websites, blogs, and social media accounts from the networks echoed the same, which conflicted with later correct reports from news sites that had waited to read the ruling more thoroughly. The conflicting reports sowed confusion among the press, viewers, and even the White House, and it would take almost thirty minutes before reporters reached a consensus.[1]

The errors were widely regarded as an unfortunate consequence of the trade-offs that journalists face between speed and accuracy in reporting. The technology to report news as it happens, combined with the threat of preemption by competitors has made instantaneous reporting more frequent, and many journalists have warned about the negative consequences it has had on the quality of reporting (Garrison, 2000; Rosenberg and Feldman, 2008). For example, early but false reporting about crimes can damage the reputations of the falsely accused, as the 2013 Boston Marathon bombing or the 1996 Centennial Olympic Park bombing have shown. Experiments have shown that published corrections have limited effectiveness in correcting misperceptions generated by news errors, especially when the listener is predisposed to believe the initial error, or find the initial error threatening.[2]

In this chapter, we model the impact that a competitive desire to preempt has on a firm's willingness to wait for more information. Two Senders wish to make a report that matches an unknown state. Evidence arrives over time and is modeled as a Poisson process with an arrival rate conditional on the state. When evidence arrives, it is privately observed, and fully reveals the state, but players do not need evidence to make a report. The first to report receives a prize, and

[1] Goldstein (2012)
[2] Kuklinski et al. (2000); Nyhan and Reifler (2010); Garrett, Nisbet and Lynch (2013)

in the event of a tie, they split the prize. We fully characterize the equilibria that result, with extra attention given to equilibria where the first report is made at time zero, which we call *early reporting.*

The model is in discrete time with arbitrarily small period length, to describe news providers with the technology to preempt each other by arbitrarily small amounts of time. Within arbitrarily small periods, the probability of the arrival of evidence approaches zero. As learning within a period approaches zero, the game approaches a zero sum game with competitive preemption concerns dominating informational ones.[3]

We have several important results. First, directly modeling a state and information arrival process can yield an expected utility of reporting that is non-monotonic over time. If a player's belief about the most likely state shifts from one state to another, the expected utility of reporting falls initially and then rises over time. This generates novel equilibrium structures where players report as soon as the game starts without waiting for any information. The off-path equilibrium strategies that support early reporting have the same pattern of competitively preemptive reporting found in other preemption settings, but can also contain *quiet periods* where confidence in the state is low, and both players do not report.

Second, we consider the utility of a Receiver who wants to take an action that matches the state, and has exponential costs of delay. We begin with a benchmark direct observer who can directly observe the evidence of the Senders, and compare his payoffs to those of a *Bayesian* Receiver, who can only view the Sender's reports. Competition reduces the payoffs of the uninformed Receiver by reducing the length of time Senders are willing to wait for evidence. We specify a behavioral *Credulous* Receiver that can only observe Sender reports, but also believes that all reports are generated by the arrival of evidence. While there exist early report equilibria where Bayesian Receivers gain information, Credulous Receivers remain uninformed in all early report equilibria. Bayesian Receivers can correctly infer that early reports are not based on evidence and continue to wait,

[3]We avoid modeling directly in continous time because the strategy space for extensive form games in continuous time are not well-defined. For more, see Simon and Stinchcombe (1989); Bergin and Macleod (1993).

while Credulous Receivers are fooled and act immediately.

We examine the effect of waiting periods, where Senders are not allowed to make a report, and find waiting periods can dramatically improve the utility of Bayesian and Credulous Receivers. One of the novel predictions is that a small waiting period can have a much larger impact on the length of time players will wait for information. The *direct effect* of a waiting period on the Sender's information is that it allows Senders the opportunity to collect evidence during the period. After the waiting period, Senders may have lower confidence in the state and may endogenously choose to continue to wait - this we call the *indirect effect*. We find that for sufficiently patient Receivers, short waiting periods can improve the utility of both Bayesian and credulous Receivers by convincing early report Senders to wait for evidence for a relatively long time.

Finally, we explore several extensions to the model. We look at a setting with more than two states, give conditions for the existence of nonmonotonicities in confidence, and argue that the same structure of equilibria in the main model exist in an arbitrary finite state model. We extend the model to $n > 2$ players competing for $k < n$ prizes, and find the same nonmonotonicities in confidence and quiet periods from the main model can still exist. We also consider a finite horizon variant of the main model, where the game ends after a finite time known to both players. We find an increased incentive to preempt as the game length shortens, because a preempted player has less time to acquire evidence.

Although this paper is motivated by the market for news provision, we can also construe the model as a more general description of preemption incentives with information arrival. One potential application is in product design, where competing firms wish to choose designs that match a customer's unknown preferences. Firms learn about customer preferences over time, but have incentives to preempt each other and gain an incumbent advantage by entering early. Many real options settings have decisions where value depends on an unknown state of the world, and the intuitions from this paper may inform future attempts to model these settings.

Related Literature.

The majority of literature on preemption games has focused on patent races (Loury, 1979; Stiglitz, 1980; Reinganum, 1982; Fudenberg et al., 1983; Weeds, 2002), technology adoption (Reinganum, 1981; Fudenberg and Tirole, 1985), and market entry (Lambrecht and Perraudin, 2003). In these settings the expected utility of action (i.e., patenting, adoption, entry) is weakly increasing. In their respective settings, this assumption is reasonable - for example, technological research generally increases the value of a potential patent. For informational settings, though, information does not always increases the expected utility of action. This paper's main departure from prior preemption literature is that information can reduce confidence in the state, thus lowering the expected utility of reporting, which generates equilibria that have not been seen in previous preemption settings.

Hopenhayn and Squintani (2011) examine a preemption game where technological innovations arrive over time and are privately observed. They are able to show existence, but not uniqueness, of equilibria where as calendar time progresses and no action has been taken, players become more afraid that their opponents will preempt them, which decreases their willingness to wait for more information. In contrast, this paper assumes all evidence fully reveals the state. This simplifying assumption allows us fully characterize all perfect Bayesian equilibria, and show that all PBE are public and payoff equivalent.

Fuchs and Skrzypacz (2013) study a dynamic market with asymmetric information in continuous time, and find that continuous trading can always be improved upon by imposing a short "lock-up" period where trading is not allowed. Their intuition resembles the "quiet period" of our model as exogenous constraints on actions induce endogenous delay, but in their setting, endogenous delay is generated by the screening of types, while the stochastic arrival of information generates ours. Sannikov and Skrzypacz (2007) examine the possibility of collusion with imperfect monitoring and flexible production in continuous time. The intuition of their main result is that collusion is impossible in continous time, because firms are able to respond immediately to the arrival of any information. In our setting, the unravelling travels in the opposite direction - the potential to acquire information is destroyed because each player can preempt his oponent by an arbitrarily small amount of time, with negligible impact on information acquisition.

Another class of timing games prescribes no externalities between players except purely informational ones (Chamley and Gale, 1994; Chamley, 2004; Murto and Välimäki, 2011, 2013). In these models, privately informed players infer an unknown common payoff parameter, by observing the actions of other players. The potential for observational learning creates an endogenous benefit of delay.

We present the model in Section 1.2 and Section 1.3 characterizes its equilibria. Section 1.4 compares the utility of Bayesian and credulous Receivers to the benchmark Direct Observer in monopoly and duopoly settings. It also considers the potential benefit of waiting periods to improve the Receivers' expected utility. Section 1.5 explores extending the model to a larger number of players and states, and explores finite horizon games.

1.2 The Model

Let there be two Senders, 1 and 2, and a state $\omega \in \{H, L\}$. Senders do not know the state and have an initial belief $\mu_0 = \Pr(\omega = H)$.

Each Sender privately observes a Poisson process with hazard rate $\lambda_{i,\omega}$, where an arrival fully reveals the state. We will assume that $\lambda_{i,H} > \lambda_{i,L}$, and that $\lambda_{1,\omega} \leq \lambda_{2,\omega}$. The first assumption guarantees that the H state generates signals more frequently than the L state and that players learn in the absence of evidence.[4] The second assumption allows for players with asymmetric signal quality, with player 2 having the stronger signal in both states. Let $\lambda_\omega = \lambda_{1,\omega} + \lambda_{2,\omega}$ be the aggregate arrival rate from both Senders.

At each $k\Delta$ for $k \in \{0, 1, 2, ...\}$, there is a decision node. At each node, each Sender simultaneously takes a public action $m_{i,t} \in \{H, L, \emptyset\}$ unless she has chosen H or L in a previous node, in which case she can take no action. If $m_{i,t} \in \{H, L\}$, she has *reported* and gets 1 util if $m_{i,t} = \omega$, 0 otherwise. If $m_{i,t} = \emptyset$, the Sender *waits* and receives no utils that round, but retains the option to choose H or L at

[4] The set of signals with identical rate has measure zero, so this assumption is without loss of generality.

a future node.

Let $\beta(\omega, m)$ be the preemption prize function. The first player to report receives $\beta(\omega, m_{i,t})$, and if Senders are tied, each receives $\frac{1}{2}\beta(\omega, m_{i,t})$. We assume that preemption prizes are weakly greater if Senders are correct about the state, $\beta(\omega, \omega) \geq \beta(\omega, -\omega)$, and that $\beta(\omega, -\omega) < 1$. If a Sender is preempted, she still retains the ability to make a report, but cannot receive the preemption prize.

The utility functions for the Senders are

$$U_i(m_{i,t}) = \beta(\omega, m_{i,t})\mathbb{1}_{\text{first}} + \frac{1}{2}\beta(\omega, m_{i,t})\mathbb{1}_{\text{tie}} + \mathbb{1}_{m_i=\omega}. \tag{1.1}$$

Let a *signal history* $S_t^i \in \mathcal{S}$ be the set of all arrival times of evidence, for i at time t, and the *action history* $A_t^i \in \mathcal{A}$ be the set of all observed actions by player i at time t. Let a *history* $\mathcal{H}_t^i \in \mathcal{H} = \mathcal{S} \times \mathcal{A}$ be the product of a signal and action history. If player i has observed no signal arrivals or actions by time t, let $\mathcal{H}_t^i = Q_t$. We will call this history a *quiet history*.

Let $\mu_i(\mathcal{H}_t^i)$ be player i's belief about the probability that $\theta = H$ at time t.

Let $\alpha_{i,t}(a) \in A$ be the mixture probability, where $\alpha_{i,t}(a)$ is the probability that i plays a at t. A *strategy* $\sigma_i : \mathcal{H} \to A$ is a mapping from histories to mixed probabilities.

Our solution concept will be perfect Bayesian equilibrium, which requires that players' strategies are sequentially rational given their beliefs, and that each player has beliefs that are consistent with equilibrium strategies and use Bayes' Rule when possible.

1.3 Results

1.3.1 Preliminaries

We begin with results that drastically simplify the problem.

To characterize equilibrium strategies we compare the value of acting in the next period and the value of waiting. Let $R_i(0, \mu)$ be player i's expected utility for reporting if player j does not act. player i's expected utility for reporting if player

j also reports.

$$R_i(\mu_i, m_j) = \max_{m_i \in \{H,L\}} \mathbb{E}_{\mu_i} U_i(m_i)|_{m_j}.$$

where

Because R_i is the maximum of a decreasing and an increasing function of t, it is nonmonotonic if the Senders prefer to report H rather than L at time zero. Define $\breve{\mu}$ as the belief at which R_i changes the state they would prefer to report.

$$\breve{\mu} = \frac{1 + \beta(L,L) - \beta(L,H)}{2 + \beta(H,H) - \beta(L,H) + \beta(L,L) - \beta(H,L)}.$$

R_i is nonmonotonic if $\mu_0 > \breve{\mu}$.

As a special case that may yield some intuition, notice that if Senders receive a constant preemption prize regardless of the accuracy of their report, i.e., $\beta(\omega, \omega) = \beta(\omega, -\omega)$, then R_i is nonmonotonic when $\mu_0 > \frac{1}{2}$.

Proposition 1. *For all PBE strategies, if a Sender receives evidence, he reports at the next decision node.*

We proceed by showing that strategies where a player delays reporting does not survive iterated deletion, and thus any PBE must have players reporting at the nearest possible node. Conditional on evidence arrival for Sender i, reporting immediately attains the maximum payoff of $1 + \beta(\omega, \omega)$, and is a weakly dominant strategy. The only case when delay can attain the same payoff is when her opponent's strategy is to delay, such that the probability of her opponent reporting during her delay period is zero, namely for j to delay beyond i's report time. j's strategy though, is dominated by immediate reporting. We can iterate this argument until the only strategies that survive involve reporting at the next node. Upon the arrival of evidence, the Sender is certain of the state and reports immediately.

Given the simplicity in each Sender's strategy upon evidence arrival, we can limit our analysis to the decision of when to report, conditional on no evidence or reports. Conditional on no reports by j, i can infer from Proposition 1 that j has received no evidence. We can then calculate each Sender's beliefs about the state conditional on no evidence or reports.

$$\mu_i(Q_t) = \frac{\mu_0 e^{-\lambda_H t}}{\mu_0 e^{-\lambda_H t} + (1-\mu_0)e^{-\lambda_L t}}.$$

Note that $\mu_1(Q_t) = \mu_2(Q_t)$, as each player can infer both players' histories, and both start with the same prior. For simplicity, let $\mu(t) = \mu_i(Q_t)$.

The PBE is characterized by backward induction, and the next lemma establishes that there exists a point to induct backwards from. Define $\bar{t}$ such that

$$\mu(\bar{t}) = \frac{\beta(L,L)}{1+\beta(L,L)-\beta(H,L)}$$

which is the last time where $R_i(\mu(t),\emptyset) = 1$. If no such t exists, let $\bar{t} = 0$.

Lemma 1. *There exists $\hat{t} > \bar{t}$ such that for all PBE, and all $t > \hat{t}$, either $\sigma_1(Q_t) = L$ or $\sigma_2(Q_t) = L$.*

As $t \to \infty$, $\mu(t) \to 0$, and both players become more confident that the state is L. $R_i(\mu,\emptyset) \to 1 + \beta(L,L)$, and the period game approaches a zero sum game. Therefore, for t sufficiently large, at least one Sender reports.

Lemma 2. *There exists $\bar{\Delta}$ such that $\forall \Delta < \bar{\Delta}$ and $t \in (\bar{t},\infty)$, all pure strategy PBE have $\sigma_i(Q_t) = L$ for at least one Sender.*

We can induct backwards from $\hat{t}$, and find a cutoff $\bar{t}$ where competitively preemptive reporting that extends to infinity begins. Given Lemma 1, we can assume that there exists a $\hat{t}$ when at least one player will report with probability 1 and the game will end. Suppose at $\hat{t}-\Delta$ neither Sender reports. R_i is continuous, so as $\Delta \to 0$, the expected utility of reporting approaches $R_i(\hat{t},\emptyset)$, while the payoff for being preempted remains 1. As $\Delta \to 0$, the probability of a evidence arrival in $(\hat{t}-\Delta,\hat{t})$ approaches zero. $R_i(\mu(\hat{t}),\emptyset) > 1$, so if a j reports at $\hat{t}$, i prefers to report at $\hat{t}-\Delta$. We can iterate this backwards for all $t \in (\bar{t},\infty)$ to produce the lemma.

Another interesting feature of this lemma is that it provides the identity of the player reporting after $\bar{t}$. Given $\lambda_{2,\omega} > \lambda_{1,\omega}$, Sender 1 always has weaker information incentives to delay. For Δ close to zero, we can show player 1 always prefers to be the first to report after $\bar{t}$, while Sender 2 strictly prefers to wait because of the slightly higher probability that he will receive evidence and 1 won't.

Define $\underline{t}$ as

$$\mu(\underline{t}) = \frac{1-\beta(L,H)}{1+\beta(H,H)-\beta(L,H)}$$

which is the first time that $R_i(\mu(t),\emptyset) = 1$, with R_i decreasing. If μ does not attain this value for any t, $\underline{t} = 0$

Lemma 3. *There exists $\bar{\Delta}$ such that for all $\Delta < \bar{\Delta}$ and $t \in (\underline{t}, \bar{t})$, $\sigma_i(Q_t) = \emptyset$ for all PBE.*

This lemma describes a *quiet period*, when Senders have weak beliefs and prefer to wait rather than report. When $t \in (\underline{t}, \bar{t})$, $R_i(\mu, \emptyset) < 1$. The continuation value for each player is bounded above the utility of being preempted, because a player can always to choose to wait and/or preempted as a strategy. If the expected utility of reporting is below 1, then players would strictly prefer to wait rather than report.

Lemma 4. *For all PBE strategies, if for some $\tilde{t}$, $\sigma_i(Q_{\tilde{t}}) = H$, then for all $t < \tilde{t}$, either $\sigma_i(Q_t) = H$ or $\sigma_j(Q_t) = H$.*

If a Sender prefers to report H, at least one Sender prefers to report H at all previous periods. The logic is similar to that of Lemma 2. As $\Delta \to 0$, the probability of an arrival goes to zero, and preemption concerns dominate. If at some time a Sender prefers to report H conditional on a quiet history, at least one player prefers to report H before that time, because beliefs about the state being H are higher at earlier times. Inducting backwards, $\mu(t)$ is greater as t approaches zero, so Lemma 4 shows that if a player chooses H conditional on a quiet history, then at least one player chooses H at all periods before, including at time zero.

Now we turn our attention to when Senders would report H without evidence. Let W_i be the value function under the Lemma 3 assumption that both Senders wait until $\bar{t}$ before at least one reports.

$$W_i(t) = 1 + \int_t^{\bar{t}} \mu(s)\lambda_{i,H}e^{-\lambda_H s}\beta(H,H) + (1-\mu(s))\lambda_{i,L}e^{-\lambda_L s}\beta(L,L)ds$$

$W_i(t)$ includes the probability that evidence arrives for i and he receives preemption prize β. It also includes the probability that evidence does not arrive and at least one Sender reports at $\bar{t}$. Technically, players wait until the first node after $\bar{t}$, and evidence can potentially arrive for both players within a given period. However, as $\Delta \to 0$, we show that the true value of waiting in the discrete time game uniformly converges to $W_i(t)$. As Δ approaches zero, the first node after $\bar{t}$ approaches $\bar{t}$, and the probability of evidence arriving for both players in a period approaches zero, and $W_i(t)$ becomes a better approximation.

Player 2 by assumption has weakly greater arrival rates. If $\lambda_{2,\omega} > \lambda_{1,\omega}$ then $W_2(t) > W_1(t)$. This implies that 1, the less informed player, is more likely to prefer to report H rather than wait until the $\bar{t}$ cutoff.

1.3.2 Pure Strategy Equilibria

We now turn our attention to the main result of this paper, the equilibrium characterization theorem.

Theorem 1. *There exists $\bar{\Delta}$ such that $\forall \Delta < \bar{\Delta}$, exactly one of the following is true:*

- ***Late Report.*** *In all pure strategy PBE, conditional on a quiet history, Sender 1 makes the first report at the first node after $\bar{t} > 0$.*
- ***Single Early Report.*** *All pure strategy PBE have exactly one Sender reporting at $t = 0$.*
- ***Double Early Report.*** *All pure strategy PBE have both Senders reporting at $t = 0$.*

We will characterize each type of equilibrium and provide the conditions that define the three cases.

Late Report Equilibria

In *late report* equilibria, conditional on no reports or evidence, Senders wait until $\bar{t}$ before reporting, and $\bar{t} > 0$. Sender 1 is the first to report at the node after $\bar{t}$, because he has the smaller probability of receiving evidence in each period and

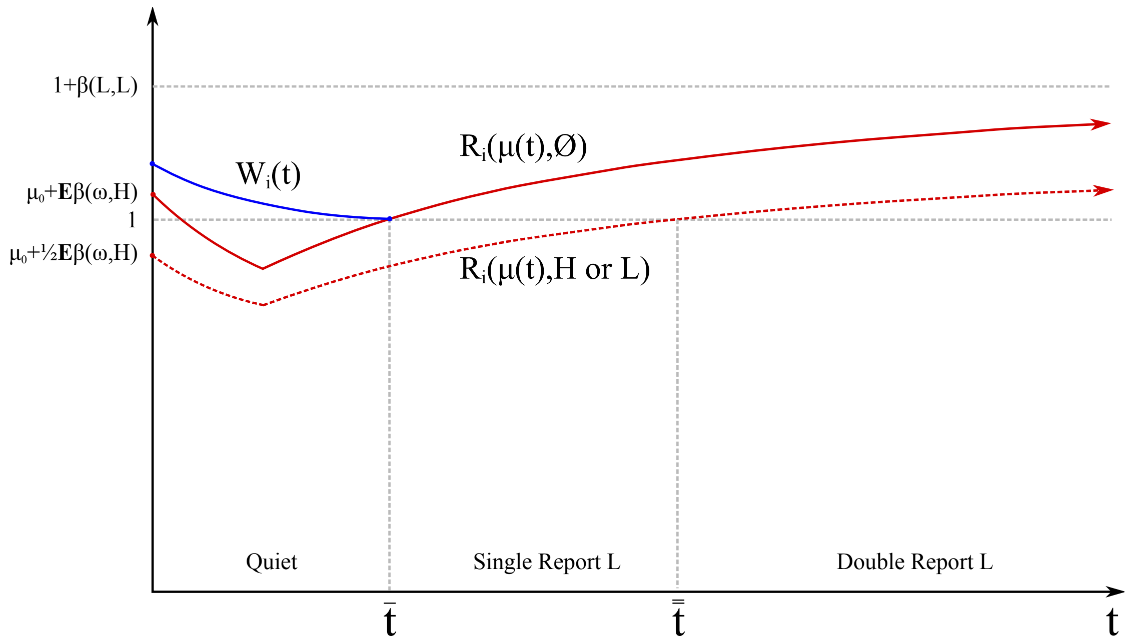

Figure 1.1: Late report equilibria, with first report at $\bar{t}$.

a weaker incentive to wait. For Δ sufficiently close to zero, all pure strategy will be *late report* equilibria if the following condition is true.

Condition 1 (Late Report)**.** $\bar{t} > 0$*, and for all* $t < \bar{t}$*,* $W_i(t) > R_i(\mu(t), \emptyset)$*.*

By Lemma 1 and Lemma 2, Senders report at all $t > \bar{t}$. In Figure 1.1, $R_i(\mu(t), \emptyset)$ is nonmonotonic, but does not cross $W_i(t)$ before $\bar{t}$. If $W_i(t) > R_i(\mu(t), \emptyset)$ for all $t < \bar{t}$ each player prefers to wait until $\bar{t}$ rather than report.

If R_i is monotonically increasing, then Condition 1 is trivially satisified, because for $t < \bar{t}$, $R_i(\mu(t), \emptyset) < 1 < W_i(t)$. In this case, the structure of these equilibria resembles those of prior preemption games, where regularity assumptions have the marginal benefit of preemption strictly increasing. In general, this model can have a nonmonotonic R_i, which requires Condition 1 to ensure a cutoff.

By examining $R_i(\mu(t), m_j)|_{m_j \neq \emptyset}$, we can characterize how many Senders report at each node. Define $\bar{\bar{t}}$ as

$$\mu(\bar{\bar{t}}) = \frac{\frac{1}{2}\beta(L, L)}{1 + \frac{1}{2}[\beta(L, L) - \beta(H, L)]}$$

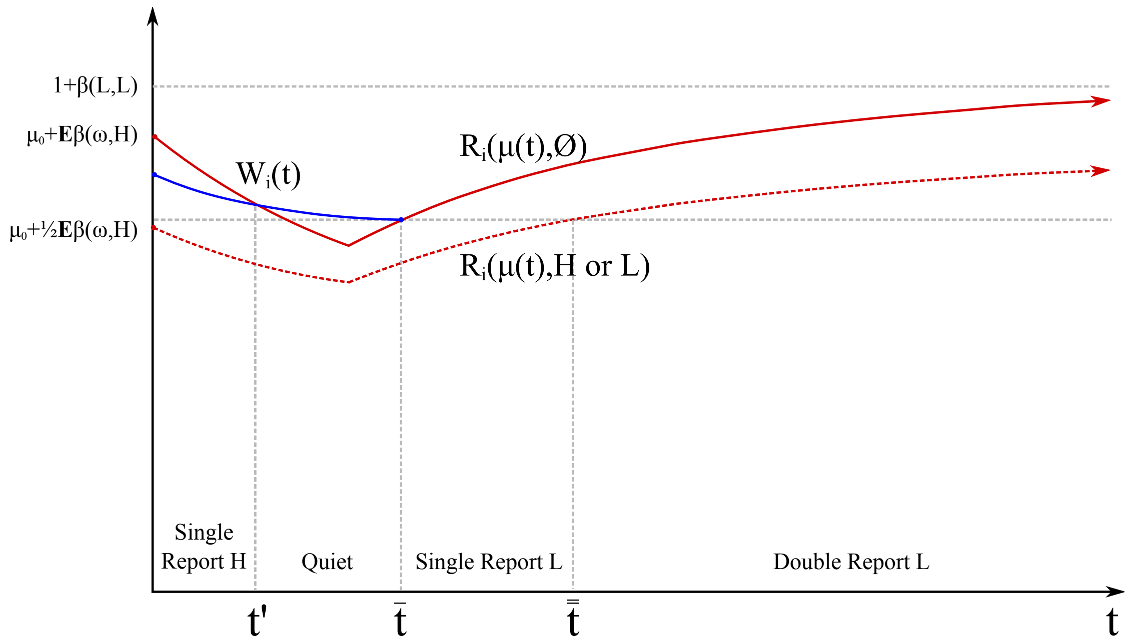

Figure 1.2: Single early report equilibria, with exactly one Sender report at $t = 0$.

which is the last time that $R_i(\mu(t), m_j)|_{m_j \neq \emptyset} = 1$. If no t attains this value, then let $\bar{\bar{t}} = 0$. For $t \in (\bar{t}, \bar{\bar{t}})$, by Lemma 2, at least one player reports at each node, but because $R_i(\mu(t), m_j)|_{m_j \neq \emptyset}$, the preemption prize is not large enough to sustain two Senders simultaneously reporting. For $t > \bar{\bar{t}}$, Senders prefer to split the prize rather than be preempted, so both Senders report at each opportunity.

Property 1. *$\bar{t}$ and $\bar{\bar{t}}$ are decreasing in $\beta(L, L)$ and $\beta(H, L)$.*

As $\beta(\omega, L)$ increases, the incentives to report L first rise, while the utility of being preempted remain constant, so the cutoff at which the first Sender chooses to report decreases. Although $\bar{t}$ is continuous in $\beta(L, L)$ and $\beta(H, L)$, if $W_i(t)$ crosses $R_i(\mu(t), \emptyset)$ as $\beta(\omega, L)$ increases, then the time of the first report jumps discontinuously from $\bar{t}$ to zero, and all equilibria shift from late report to single early reports.

Single Early Report Equilibria

In *single early report* equilibria, exactly one Sender reports at $t = 0$. All pure strategy PBE are early report equilibria if Condition 1 fails. We know that we all pure strategy PBE are early report equilibria because if Condition 1 fails, one of two cases is true. Either $\bar{t} = 0$ and by Lemma 2 we have reporting at $t = 0$,[5] or $\exists t' < \bar{t}$ such that $W_i(t') = R_i(\mu(t'), \emptyset)$, and by Lemma 4 we can induct backwards to show players report at each period in $[0, t')$. The following condition distinguishes single early from double early reports.

Condition 2 (Single Early Report)**.** $R_i(\mu_0, m_j)|_{m_j \neq \emptyset} < 1$.

If the condition is true, then only one Sender reports at $t = 0$, and the other Sender prefers to wait for evidence rather than split the prize.

The structure of off equilibrium path behavior depends on the reason Condition 1 fails. If it fails because $\bar{t} = 0$, then Lemma 2 reasoning has competitively preemptive reporting at all t. If $\bar{t} > 0$ as in Figure 1.2, then off path equilibrium play contains a quiet period in $(t', \bar{t})$.

For the nonmonotonic case pictured in the figure, it is important to note that if $W_i(t)$ crosses $R_i(\mu(t), \emptyset)$ at some t', its value before t' is no longer important. Inducting backwards, given that at least one report is made at t', choosing to wait at a node before t' does not entail waiting to $\bar{t}$.

Although in late equilibria we could identify the first Sender to report, this is not the case for single early report equilibria. This is because in the late report case, incentives to report shrank when approaching $\bar{t}$ from the right, and Sender 1 always had lower incentives to wait than Sender 2. At $t = 0$, expected utility of reporting remains high for both players, and the asymmetry in evidence arrival rates does not alter the fact that each player prefers to be the only Sender to report, rather than be preempted.

Double Early Report Equilibria

In *double early report* equilibria, both Senders report at $t = 0$. All pure strategy PBE are double early report equilibria when Condition 1 and 2 do not hold. The major difference between a double early report and a single early report is the number of reporters at time zero, as well as the competitively preemptive

[5] We include figures of monotonic early report equilibria in the appendix.

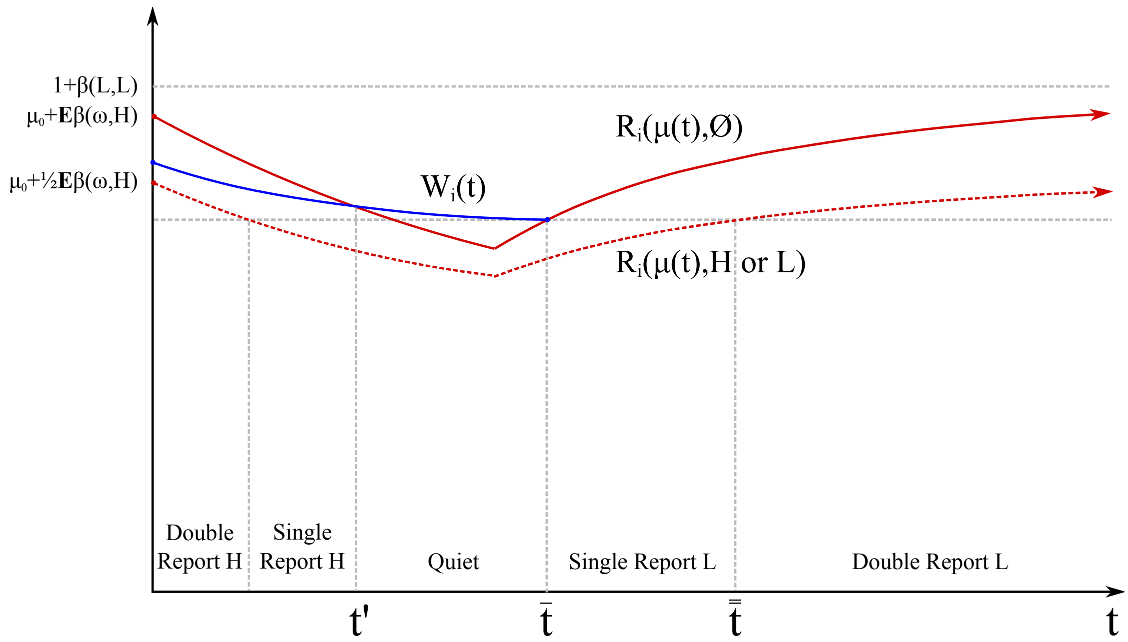

Figure 1.3: Double early report, both Senders report at $t = 0$.

reporting that supports the time zero report. In the case with nonomonotonic R_i, a period $[0, \underline{t})$ where both Senders report supports time zero reporting. For double early reports in the monotonic R_i case, both Senders report at all t.[6]

1.4 Receivers

We have described framework as a model of the tradeoffs that journalists and news organizations face when deciding when to publish a story, and thus far implied that consumers are harmed when preemption incentives prevent news providers from collecting evidence. In this section, we will explore the impact that Sender competition and preemption incentives have on the utility of a few benchmark Receivers. In the first setting, we consider a benchmark *Direct Observer* with exponential discounting who wants to take an action that matches the state. She does not know the state, but can directly observe the Sender's private signals.

We compare the Direct Observer's utility to two Receivers, the Bayesian and the Credulous. A *Bayesian Receiver* faces the same decision problem, but is

[6]A figure for the monotonic case is in the appendix.

only able to observe the Sender's messages, and uses Bayes' Rule to infer whether the Sender's messages are based on the arrival of evidence. Finally, we consider a *Credulous Receiver* who faces the same decision problem, but assumes that all reports from Senders are based on the arrival of evidence. Although many empirical works have studied the rise of media bias and its impact on political and economic behavior (DellaVigna and Kaplan, 2007; Gentzkow and Shapiro, 2006, 2010), numerous media perception surveys (Wilson and Howard, 1977; Gaziano and McGrath, 1986; Pew Research Center, 2009) have found that media consumers are more likely to characterize their news sources as "accurate" or "gets the facts straight" than "unbiased" or "fair." We construe Credulous Receivers as an extreme example of consumer faith in media accuracy, and compare their ex ante expected utility with the other Receiver benchmarks.

1.4.1 Direct Observer

Let there be a *Direct Observer* with discount rate r, that can take an action $a_D \in \{H, L\}$ at any time $t_D \in \{\Delta, 2\Delta, \cdots\}$. The Observer's utility is

$$U_D(a_D, t_D) = e^{-rt_D}\mathbb{1}|_{a_D=\theta}.$$

We can assume that the Direct Observer has access to a composite signal, with arrival rates λ_H and λ_L, respectively. Given any arrival of evidence, the Direct Observer will immediately report at the next available node. The next lemma shows that given no signal arrivals, there exists a cutoff time when the Observer will eventually act without evidence.

Proposition 2. *When the Observer can observe signals with arrival rate λ_H and λ_L, there exists an optimal $\bar{t}_D$ and $\bar{\mu}_D = \mu(\bar{t}_D)$ such that*

$$\bar{t}_D = \arg\max_{a_D, t_D} \mathbb{E}U(a_D, t_D|Q_t).$$

The expected utility of acting for an Direct Observer is potentially nonmonotonic, just as in the Sender's case for reporting. If the Receiver initially prefers to take action H initially, her expected utility for action is nonmonotonic, and she may prefer to act at time zero, with $\bar{t}_I = 0$. There exist parameter values where the Direct Observer still wishes to act at $t = 0$, while Senders prefer to wait at $\bar{t} > 0$. This can be achieved by setting μ_0, $\beta(L, L)$, δ large, all other β small. Needless to say, in such cases a Direct Observer's utility is not sensitive to the Sender's equilibrium behavior. For this reason, we focus our analysis on cases where $\bar{t}_I > 0$.

1.4.2 Bayesian Receiver

We next examine a *Bayesian Receiver*, who faces the same decision problem as the Direct Observer. She has discount rate r, can take an action $a_B \in \{H, L\}$ at any time $t_B \in \{\Delta, 2\Delta, \cdots\}$. The Bayesian Receiver's utility is

$$U_B(a_B, t_B) = e^{-rt_B} \mathbb{1}|_{a_B=\theta}.$$

The Bayesian Receiver uses Bayes' Rule to infer from Sender's messages and timing the information that Senders have received. For example, she can deduce that if a Sender has not reported, then that Sender has not received any evidence. Similarly, because the Receiver knows the time Senders will send their message in a quiet history in pure strategy equilibria, she knows messages sent at times other than 0 or $\bar{t}$ reveal that a Sender has received evidence.

Proposition 3. *A Bayesian Receiver and Direct Observer have the same ex ante expected utility if and only if $\bar{t} \geq \bar{t}_D$ and all pure strategy PBE are late equilibria.*

The Bayesian Receiver is able to infer the Sender's lack of evidence conditional on a quiet history, and only differs from an Direct Observer in her inability to gain information after a Sender reports with no evidence. While a Direct Observer is unaffected by a Sender's decision to report without evidence, a Bayesian Receiver is also unpersuaded by the report, but ceases to learn from that Sender. Thus the Bayesian is only harmed relative to a Direct Observer when Senders report without evidence before $\bar{t}_D$.

In the next proposition, we compare the Bayesian Receiver's utility under the duopoly setting of the main model, with a monopolist Sender with no competitor.

Proposition 4. *If $\bar{t}_I > 0$ and all Sender duopoly pure strategy PBE are:*

- *double early report equilibria, a Bayesian Receiver strictly prefers a monopolist Sender to duopoly.*
- *single early report equilibria, a Bayesian Receiver is indifferent between duopoly and monopoly.*
- *late report equilibria, a Bayesian Receiver strictly prefers duopoly to monopoly if $\bar{t}_I \leq \bar{t}$.*

In the double early report duopoly, a Bayesian Receiver gets no information from Senders, and would prefer a monopolist Sender, even though a monopolist's single signal collects evidence at a slower rate than two Senders. For single early report duopoly, the first Sender to report is ignored by the Bayesian Receiver, so the Receiver is indifferent. Finally, in late report douopoly, if $\bar{t}_I < \bar{t}$, the Bayesian Receiver has access to the same information as the Direct Observer until $\bar{t}$, and would thus choose to stop at $\bar{t}_I$. Then the fact that competitive preemption causes Senders to stop at $\bar{t}$ does not affect the Bayesian Receiver's utility.

1.4.3 Credulous Receiver

Next we examine a *Credulous Receiver*, who faces the same decision problem as the Direct Observer. She has discount rate r, can take an action $a_C \in \{H, L\}$ at any time $t_C \in \{\Delta, 2\Delta, \cdots\}$. The Credulous Receiver's utility is

$$U_C(a_C, t_C) = e^{-rt_C} \mathbb{1}|_{a_C=\theta}.$$

The Credulous Receiver assumes that the Sender's strategy sends a message if and only if a signal has arrived. For example, for pure strategy equilibria where a Sender sends a message at $t = 0$, a naive Receiver assumes that this is because of the arrival of evidence at $t = 0$, while a sophisticated Receiver knows that this message contains no information and ignores it.

Proposition 5. *The ex ante expected utility of the Credulous Receiver and the Direct Observer are equal if and only if $\bar{t} \geq \bar{t}_D$ and all pure strategy PBE are late report equilibria.*

The proposition may be surprising, given that this is the same condition as Proposition 3. The fundamental difference between the Credulous and the Bayesian Receiver is how they react to reports without evidence. Although the Bayesian Receiver is harmed because she loses access to that Sender's signal for the remainder of the game, the Credulous Receiver is harmed even more, because her credulity causes her to act too early. But, because their payoffs only diverge from the Direct Observer when a report without evidence is made, we can expect their ex ante expected utility to be equal to the Direct Observer only when uninformed reports are made after $\bar{t}_D$.

Finally, we compare the Credulous Receiver's payoffs under the Sender duopoly of the main model versus under a monopolist.

Proposition 6. *If* $\bar{t}_I > 0$ *and all Sender duopoly pure strategy PBE are:*

- *double early report equilibria, a Credulous Receiver strictly prefers a monopolist Sender to duopoly.*
- *single early report equilibria, a Credulous Receiver strictly prefers a monopolist Sender to duopoly.*
- *late report equilibria, a Credulous Receiver strictly prefers duopoly to monopoly if* $\bar{t}_I \leq \bar{t}$*.*

The Credulous Receiver is just as harmed by double early reports as the Bayesian. The Credulous Receiver is harmed because she believes the reports, while the Bayesian is harmed because of the loss of information. For single early reports, the Credulous Receiver also believe the first report, and would receive higher ex ante payoffs under a monopolist, who waits for evidence. The Bayesian outperforms the Credulous Receiver under single early reports, because the she is able to ignore the first Sender's useless report. Under late report equilibria and $\bar{t}_I < \bar{t}$, the Credulous Receiver prefers duopoly because of the higher aggregate learning rate. Her credulity does not harm her because Senders report without evidence only after she would have already acted without evidence.

1.4.4 Waiting Periods

Press embargoes and gag orders are sometimes used to prevent news agencies from providing information to its audiences that might induce them to take harmful or premature actions. For example, courtrooms frequently place gag orders on trial participants with the goal of preserving "participants' rights to a fair trial," and to "avoid contaminating the jury pool" (Apfel, 1979; Todd, 1990; Minnefor, 1995).

We can also construe waiting periods as an exogenous technological or institutional constraint on the speed at which information can be reported. For example, newspapers publish at most three times per day, and prior to cable news, television networks would have a single daily evening news show. The instant a potential story arrives, technological and institutional constraints[7] provide time for reporters to gather information before producers decided whether to report. Thus an increase to a waiting period can be construed as a potential policy a planner might wish to implement, while a decrease can be construed as a relaxation of physical or institutional delays on reporting due to technological progress.

Let a τ-*waiting period* be a period $[0, \tau)$ for $\tau \in \{\Delta, 2\Delta, \cdots\}$ when neither Sender can report. Evidence will continue to arrive in $[0, \tau)$. Receivers are still able to act at any node. Our first result shows that short waiting periods have limited effectiveness.

Proposition 7. *If all pure strategy PBE are...*

- *late report equilibria, then Bayesian and Credulous Receivers strictly prefer no waiting period over a $\tau < \bar{t}$ waiting period.*

- *double early report equilibria, then there exists $\tau > 0$ waiting period that Bayesian and Credulous Receivers strictly prefer no waiting period.*

- *single early report equilibria, then Credulous Receivers strictly prefer a $\tau > 0$ waiting period.*

[7]Breaking news stories allow instantaneous reporting, but unlike in cable news, not every story can be breaking news for networks.

A waiting period has two effects on the Sender's provision of information. The *direct* effect of the waiting period is that Senders delay their reports at least until τ. Senders can learn about the state from their own private signals, but are unable to report the arrival of evidence because of the waiting period. This *evidence delay* imposes costs on all Receivers..

Even worse, Receivers are unable to distinguish reports from H evidence arrival in the τ-waiting period from standard competitive preemption. If Senders report H without evidence at τ, Receivers will not be able to differentiate Senders who report H with evidence from those who report without it. Thus not only is H evidence delayed, but if it arrives, is indistinguishable from reporting without evidence. This we call the *pooling of evidence*.

The *indirect effect* of a waiting cost is that once the waiting period is over, given a quiet history, their confidence in the state might be sufficiently low to convince them to wait at τ rather than report, which yields the Receiver more information after τ. This creates a discontinuity in the benefits of waiting periods, where a waiting period that is just long enough to have an indirect effect on Senders to wait until $\bar{t}$ is much more beneficial for Receivers than a waiting period where Senders report at τ.

For late report equilibria, waiting periods only lower utility through learning delay and pooling, without any direct benefits. For $\tau > \bar{t}$, even if Receivers are sufficiently patient, the enormous amount of information lost from the pooling of evidence from the waiting period makes it hard to interpret the effectiveness of waiting periods.

For double early report equilibria, both Receiver types receive no information from Senders, so the delay and pooling costs of waiting periods have no impact. Imposing waiting costs allows a positive probability that one of the Senders will receive L evidence, which will not pool at τ.

Finally, for single early reports and Credulous Receivers, the previous argument about waiting period applies. Bayesian Receivers still receive information from the second Sender, so it is ambiguous whether the delay costs imposed on the second Sender and the pooling costs imposed on both are outweighed by the first Sender's ability to collect L evidence.

Exogenous waiting periods have several impacts on Receivers. The most obvious impact is the delay of evidence, which costs Receivers because of the delay in reporting the arrival of evidence. This model yields two other effects – the pooling of evidence can mitigate the advantage of any information collected during the waiting period, while the indirect effect can convince Senders to wait past the exogenously imposed time. Despite the costs of waiting periods, they are of a larger benefit for Credulous Receivers in early report equilibria because the delay in the first report mitigates the Receiver's inability to ignore first reports.

1.5 Extensions

In this section we discuss extensions to the main model and the potential scope of the results we've presented. This highlights the assumptions that are critical to the model, as well as the features that are merely simplified for tractibility and exposition. Section 1.5.1 considers a model with $n > 2$ states, Section 1.5.2 considers the addition of more players as well as multiple prizes, and Section 1.5.3 considers games with a finite horizon.

1.5.1 Multiple States

Consider two Senders who wish to make a report that matches an unknown state $\omega \in \{\omega_1, \omega_2, ...\omega_n\}$, with initial prior vector $\mu_0^T = (\mu_{01}, \mu_{02}, \ldots, \mu_{0n})$. with evidence arrival rates $\lambda^T = (\lambda_1, \lambda_2, \ldots, \lambda_n)$ for both players, with $\lambda_1 > \lambda_2 > ... > \lambda_n$. Consider beliefs $\mu_i(t)$, the beliefs that players have in state i conditional on quiet history Q_t.

$$\mu_i(t) = \frac{\mu_{0i} e^{-2\lambda_i t}}{\sum_{j=1}^{n} \mu_{0j} e^{-2\lambda_j t}}.$$

Let

$$B = \begin{bmatrix} B_{11} & & \\ & \ddots & \\ & & B_{nn} \end{bmatrix},$$

where B_{ij} is the preemption prize for reporting j when the state is i. As before, we require that being first and correct has the larger preemption prize than being first and wrong, $B_{ii} \geq B_{i,-i}$. Accuracy prizes remain normalized to 1 util if correct, 0 util if incorrect.

Proposition 8. *$R_i(\mu(t), m)$ is either strictly increasing or is U-shaped in t.*

We are able to show that $R_i(\mu, m)$ is either monotonically increasing, or is U-shaped, just as in the binary case. The potential for nonmonotonicity would suggest that the shape of the expected utility of reporting, then, is not a product of the binary states, but rather a fundamental property of information. Information can *decrease* as well as increase the expected utility of action. We can provide conditions for when R_i is U-shaped. If the state that the Senders would report at time zero has decreasing beliefs as t increases without evidence or reports, then R_i is U-shaped.

1.5.2 Multiple Senders with Multiple Prizes

Let's return to the binary state case. Suppose instead of two Senders there are $n > 2$ Senders, with $k < n$ prizes. Each Sender has evidence arrival rates $\lambda_{i,\omega}$, with $\lambda_{1,\omega} < \lambda_{2,\omega} < \ldots < \lambda_{n,\omega}$ and $\lambda_{i,H} > \lambda_{i,L}$.

Let there be preemption prizes $\beta_i(\omega, m)$ for $i = 1, \ldots, k$, with $\beta_1(\omega, m) > \beta_2(\omega, m) > \ldots > \beta_k(\omega, m)$ and $\beta_i(\omega, \omega) \geq \beta_i(\omega, -\omega)$. Prizes are ordered, and being correct and first yields weakly greater utility than being wrong and first. If m Senders report at the same time and are the jth Senders to report, they split the preemption prize with player i receiving $\beta_j(\omega, m_i)/m$.

At each node, Senders sequentially and publicly choose $m_i \in \{H, L, \emptyset\}$ – Sender 1 chooses m_1, Sender 2 observes 1's choice, and chooses m_2, etc. With this assumption, we are able to show that there is a weak ordering in the timing of player reports conditional on no evidence in all pure strategy PBE.

Proposition 9. *If $i < j$, then in all pure strategy PBE, conditional on no evidence or reports, Sender i reports before or at the same time as j.*

This proposition states that although Senders with the weakest signal have the highest expected evidence arrival time, they are the first to report without evidence. Conditioned on no evidence or reports, we can order the Senders by their evidence arrival rate. Unconditioned, ordering becomes problematic, as the Senders that report the latest without evidence have the shortest expected evidence arrival time.

Adding additional Senders while holding the preemption prizes constant improves the quality of information. The aggregation of Senders' independent signals means each Sender learns about the state faster. The cutoff beliefs that Senders choose to report without evidence remain the same, but because those beliefs are reached faster, Senders report sooner without evidence. For Receivers, utility gains come not from learning, as signals are truncated at the same beliefs levels as before, but come from the reduced delay costs.

Fixing the number of players, adding preemption prizes has an ambiguous effect. Adding larger first report preemption prizes certainly increases Sender's incentives to report earlier. Adding ith report preemption prizes has an ambiguous effect – incentives to report $(i-1)$th are reduced, as a Sender who is preempted for the $(i-1)$th report can wait and potentially receive an ith report preemption prize.

Although this paper takes preemption incentives as exogenous,it is likely that adding firms to a media market affects preemption incentives, as well as the utility of accurate but late reporting. We remain agnostic about this relationship, and leave this question open to a more detailed model of media consumer demand.

1.5.3 Finite Horizon

The model we have been analyzing thus far assumes that Senders have an infinite amount of time to collect evidence. We can relax this assumption, by assuming that at time $T > 0$, remaining Senders have a last opportunity to report before the game ends and Senders who have not reported receive 0 utility. This finite horizon could be the consequence of a competitive fringe of smaller news organizations, blogs, and independent journalists who use public signals to report the state. Alternatively, a third party with knowledge of the state (e.g., the government commits to a press briefing) that has committed to report the true state at T, which limits the window which Senders can profitably report.

Property 2. *In all pure strategy PBE, the time of the first and second report is weakly increasing in T.*

This variation to the game has no impact on the expected utility of reporting, but changes the expected utility of being preempted. Preempted Senders no longer wait for evidence for an indefinite period of time, but instead have a finite period with which to collect evidence, before making a final report at T. Because being preempted now entails the chance that one can still be wrong, the expected utility of reporting is less than 1, and is decreasing as t approaches T.

As T decreases Sender expected utility of being preempted shifts downwards, and Senders report earlier – $\bar{t}$ decreases. Moreover, equilibria have the potential to "shift" into a different category as T decreases – late report equilibria become single early report, and single early report equilibria become double early report equilibria.

Even though we have fixed the preemption incentives and learning rates of the players, shortening the window which players have to report can cause them to report earlier. One consequence for media markets is that as the speed of the competitive fringe using a public signal increases, the quality of first reports by privately informed Senders decreases. One could argue that while the Internet has improved the information collection abilities of news organizations, it has even more dramatically improved the speed of the competitive fringe of bloggers and independent journalists they compete with.

From an information disclosure perspective, a third party committing to disclose information in the future can reduce the immediate quality of information provided by Senders. This can create the bizarre situation where a party voluntarily discloses information in the future to temporarily suppress it in the present.

1.5.4 Delay Costs

In the main model, players are modeled without delay costs to highlight the role of preemptive competition in creating early reports. However, in this section we explore the impact that explicit delay costs have on equilibrium behavior. For example, Senders may be reporting on an event where Receiver interest declines as time progresses or where the event must compete with the stochastic arrival of other events that vie for attention. This is in contrast to the endogenous delay costs in the main model that arise purely from Senders' fear that their opponent will preempt them. Let players' utility functions now be

$$U_i(m_{i,t}) = e^{-\delta t}[\beta(\omega, m_{i,t})\mathbb{1}_{\text{first}} + \frac{1}{2}\beta(\omega, m_{i,t})\mathbb{1}_{\text{tie}} + \mathbb{1}_{m_i=\omega}].$$

Exponential discounting has several effects on players' incentives to report. First, as in the finite horizon case in Section 1.5.3, a player that has been preempted will stop waiting for evidence at a finite time. This stopping time is endogenously determined by when the remaining Sender reaches his cutoff belief, when he deems it too costly to wait for evidence. Given that the preempted Sender will stop at a finite time conditional on no evidence, the Sender's expected utility for being preempted is strictly lower than in the main model.

Second, a delay cost reduces the present value of preemption prizes in the distant future. Looking forward, a player may wish to report at $t = 0$ rather than $\bar{t}$ and receive a heavily discounted preemption prize, where in the main model without discounting may have waited until $\bar{t}$.

Proposition 10. *In all pure strategy PBE, the time of the first and second report is weakly decreasing in δ.*

This proposition states that as delay costs increase, the first report time weakly decreases. The first report time does not change with δ when it is at $t = 0$, hence the weak inequality. This leads to the intuitive result that the more costly the delay, the sooner both Senders will report, and with sufficiently high δ, all pure strategy PBE are double report equilibria.

1.6 Conclusion

This paper presents a simple model of two Senders who have incentives to preempt each other, but also to wait for information. By explicitly modeling the information structure rather than indirectly modeling an exercise value, we are able to produce unique predictions about why a Sender might prefer to not wait for evidence. Prior literature on preemption games that has focused on patent races, financial transactions, or market entry has assumed that the exercise value of information is steadily increasing while works that have focused on the problem of private information have had problems with equilibrium uniqueness.

The model improves our understanding about how a Sender's decision and information problem maps into preemption game behavior. By directly modeling information and the arrival of evidence we are able to show that the exercise value, the expected utility of reporting, can be nonmonotonic. This nonmonotonicity can create strong incentives at the beginning of the game to make reports solely based on the Sender's prior. We are also able to describe how the structure of preemption incentives (whether Senders must be correct and first, or merely first) affects the timing of Sender reports.

The tractibility of the model leaves many potential avenues for future research, especially when the model is construed more generally as one of preemption incentives and information acquisition. For example, one might be interested in the optimal compensation scheme a Receiver might implement to acquire accurate information in a timely manner. While there is no ex ante reason to believe that preemption bonuses are optimal, it would be valuable to understand how incentives for preemption compare to other compensation plans, as well as how a mechanism designer should structure an optimal mechanism under exogenous preemption incentives.

Another potential direction is to examine how costly information acquisition is affected by preemption incentives. In this paper, Senders are modeled as passive information collectors, but a variation to this model might have Senders pay a marginal cost to observe their private signal, or purchase a fixed cost investment at the beginning of the game that improves their signal. It remains an open question whether competition for the preemption incentives drives Senders to invest more heavily in information acquisition, or whether it drives Senders to invest nothing and report prematurely.

This model can also be used as a framework for product development and design. In contrast to patent and R&D models where inventions and innovations are inherently value-adding, product design and development involves learning about an unknown state of the world, consumer preferences, and making design decisions to satisfy those preferences. Directly modeling player beliefs about an unknown state is a better description of these settings than prior preemption games.

Finally, this paper has modeled the behavior of a preempted Sender in a simple way to focus on time zero reporting, by assuming that they merely wait for the arrival of evidence. In many innovation settings, the behavior of the preempted player is crucial for determining the incentives and timing of the first player to act. This model provides a framework which one could use to examine the impact of post-report play on the timing of the first report.

Chapter 2

Screening to Persuade

2.1 Introduction

In many persuasion models, players are assumed to have a common prior. For example, in Kamenica and Gentzkow (2011) and Rayo and Segal (2010), the prior of the Receiver is crucial for determining the Sender's optimal message strategy. In many environments this is a benign assumption that is essential for tractibility, but it presents two major problems. In general, a Receiver's beliefs about states are unknown to a Sender. Moreover, the Receiver may have incentives to lie about her beliefs to influence the type of messages she receives.

In this paper, a Sender (he) is trying to persuade a Receiver (she) to purchase a product, but does not know the Receiver's prior beliefs about the quality of the product, which can be High or Low. The Sender can offer a menu of signals about his product to persuade the Receiver. If the Receiver would purchase the product without a signal, she is an *optimist*, otherwise she is a *pessimist*. While a more informative signal may convince pessimists to purchase with positive probability, a poor realization of the signal may dissuade optimists. I analyze this tradeoff with a simple persuasion model and characterize the optimal menu of signals in several limited contracting environments.

The primary challenge of the Sender's screening problem is that Receivers do not satisfy the single-crossing property - the marginal utilities for the informativeness of a signal are nonmonotonic in Receiver type. Extreme pessimists may have zero marginal utility for information, as a positive signal realization is still not sufficient to sway them to take the Sender's preferred action. Extreme optimists believe a low realization to be less likely as their optimism increases, and thus have a lower marginal utility for a more informative signal.

Despite the lack of the single-crossing property, we show several results common to all of the settings we examined. First, when the Receiver's prior distribution has full support, a menu strictly outperforms a singleton, because of the usual screening intuitions. Second, the optimal mechanism in all settings excludes Receivers with extreme beliefs from receiving an informative signal. Extreme pessimists require an informative and cheap signal, which extends rents to inframarginal Receiver types. Extreme optimists, who would purchase in the absence of a signal, are excluded by imposing a strictly positive cost on all signals. Lastly, the optimal menu pools Receivers onto a finite number of signals. This is driven by the fact that the Sender and Receiver's expected utility is linear in the accuracy of the signal the Sender provides.

We examine the Sender's mechanism design problem in several limited contracting environments. In the first benchmark setting, the Sender offers a schedule of signals and transfers.

The second environment we examine allows the Sender to attach purely wasteful costs to signals. For example, a firm may wish to make information about its products costly to interpret through jargon and fine print. This serves the same screening purpose as transfers but will remain feasible even in environments where players cannot contract on the purchase of signals.

In the third environment, the Sender can condition a transfer on the Receiver's action, as well as the signal she chose. This gives the Sender additional screening power, as not only does the expected utility of signals vary by Receiver type, but so does the ex ante cost. Because the payments directly affect the payofffs of the Receiver's actions, her individual rationality constraints will limit the stakes of the transfers that can be made. [1] The optimal payment structure has a dramatic cutoff. If the Receiver is more optimistic than a cutoff type, the Sender provides information but only charges for it if the Receiver does not purchase the product. If the Receiver is more pessimistic than the cutoff type, then the Sender will only charge for information when it is purchased.

Related Literature

Several models examine persuasion when the Sender commits to a message strategy (Kamenica and Gentzkow, 2011; Kolotilin, 2014*a*,*b*; Alonso and Camara, 2013).[2] Kamenica and Gentzkow (2011) (hereafter KG) show that the Sender can profitably persaude the Receiver when the Sender's utility is convex in the

[1] Eliaz and Spiegler (2009) find similar limitations when examining optimal contracts with agents with heterogeneous priors.

[2] In earlier work, Johnson and Myatt (2006) and Lewis and Sappington (1994) examine the disclosure of information and its effect on the demand curve for a good.

Receiver's posterior. Alonso and Camara (2013) show that when the common prior assumption is relaxed, this convexity is not necessary for the Sender to profit from a committed message strategy. In a pair of papers, Kolotilin (2014b,a) examine the tradeoff between the frequency and the persuasiveness of the Sender's messages for Receivers with heterogeneous priors and private information. They characterize necessary and sufficient conditions for when the Sender profits from increasing the informativeness of the signal.

Several papers examine how obfuscation of product prices can be individually rational for the firm despite competition. Ellison and Wolitzky (2012) examine firms' decision of price and obfuscation levels in competitive settings and find that it is individually rational for firms to obfuscate their prices. Their model expands on prior literature on firm pricing decisions when consumers face exogenous search costs (Diamond (1971), Stahl (1989)), which finds that even small search costs were enough to push the equilibrium away from the competitive price.

Other models utilize bounded rationality assumptions to explain how obfuscation is individually rational for firms (Heidhues and Koszegi (2012); Gabaix and Laibson (2006)). Firms exploit naive rational consumers by avoiding mention of addons and their prices, while sophisticated consumers benefit from low base prices.

2.2 The Model

Let there be a Sender (he) and a Receiver (she). There are two states of the world, $\theta \in \{H, L\}$, where H represents a Receiver having a high valuation for a product, and L represents a low value. Receiver chooses an action $a \in \{N, B\}$. The Receiver's utility is $v(a, \theta)$, with

$$\begin{aligned} v(B,H) &= u_H > 0 \\ v(B,L) &= u_L < 0 \\ v(N,H) = v(N,L) &= 0. \end{aligned}$$

Let μ be the Receiver's beliefs about the probability of the low state, $\mu = \Pr_R(\theta = L)$ and let μ_0 be the Sender's beliefs, $\mu_0 = \Pr_S(\theta = L)$. The Sender gains

π profit if Receiver chooses $a = B$, and zero profit if Receiver chooses $a = N$. Let $f(\mu)$ be the density of Receiver beliefs, with the following assumptions on f.

- $f(\mu) > 0$, $\forall \mu \in (0, 1)$.
- $f(0) = f(1) = 0$.
- f is continuously differentiable.
- f is common knowledge.

Given that Receiver types with $\mu = 0$ or $\mu = 1$ will not change their behavior regardless of the Sender's message, assuming that their density is zero is relatively benign.

The Sender offers the Receiver a *menu* S of *signals* s. A signal is a mapping from each state to a probability distribution over messages $M = \{H, L\}$, and $s : \Omega \to \Delta M$. [3]Receiver can then choose a signal $s_i \in S$ at the associated transfer t. Sender observes θ, and sends a message with distribution $s(\theta)$ to Receiver. The Receiver observes the realized message m, and chooses action a.

The Receiver's realized utility is

$$V(a, \theta, t) = v(a, \theta) - t$$

2.3 Preliminaries

To analyze the Sender's optimization problem, we simplify the Sender's problem by constraining his possible signal choices to a set that must contain the optimal signal. It is possible to reduce our description of a signal $s : \Theta \to \Delta M$ to a single parameter α, its *accuracy*.

Lemma 5. *If a signal s^* is part of an optimal menu, then* $\Pr[s^*(H) = H] = 1$.

[3]We limit our analysis to binary signals because of a key result from Kamenica and Gentzkow (2011). The Sender is concerned only with the beliefs induced by each message, and will pool all "bad news" onto a single message, and other messages will be potentially persuasive. Any optimal mechanism with multiple messages is equivalent to a mechanism with a binary message space.

Proof. Examine a signal $\hat{s}$ such that $\Pr[\hat{s}(H) = L] > 0$. $\hat{s}$ is then dominated by a signal $s^\dagger$ such that $s^\dagger(L) = \hat{s}(L)$, but $s^\dagger(H) = H$. Offering signal $s^\dagger$gives the Receiver stronger beliefs about $\theta = H$, and in expectation convinces the Receiver a larger portion of the time. □

Because the optimal signal always discloses the H state to the Receiver, it is acceptable to restrict analysis of the optimal mechanism to signals where L is revealed with probability less than one, i.e. $\Pr(s(H) = H) = 1$, and $\Pr(s(L) = L) = \alpha$, $\alpha < 1$. From here on, we will refer to signals by their accuracy α and supress direct mention of s.

Let $U(\alpha, t, \mu)$ be the utility of Receiver that chooses $a = B$ when the message claims the state is H, and $a = N$ when the message claims the state is L.

$$U(\alpha, t, \mu) = (1 - \mu)u_H + \mu(1 - \alpha)u_L - t.$$

Define $\hat{\mu} = \frac{u_H}{u_H - u_L}$ as the *threshold Receiver*, the Receiver who is indifferent between $a = B$ and $a = N$ without a signal. Receivers with $\mu < \hat{\mu}$ we call *optimists* while those with $\mu > \hat{\mu}$ we call *pessimists*.

We examine three settings in this section. In the first setting, the Sender can offer transfers for his signals. In the second, the Sender can impose purely wasteful costs on the Receiver for signals he provides. In the third setting, the Sender can condition transfers on the Receiver's action.

2.4 Signals with Transfers

We examine a benchmark scenario where the Sender associates a transfer with each signal offered in the menu. The revelation principle from Myerson (1979) allows us to characterize the optimal mechanism as a revelation mechanism. The Receiver will report her type, and the Sender will provide a signal and associated transfer. The signal prescribes an action for the Receiver, and the Receiver takes this action. While the usual incentive compatibility constraints apply, the Receiver faces unique individual rationality constraints. First, the Receiver must prefer her prescribed signal, as well as following its prescripted action, over making the uninformed choice of a. We call these the *first stage* IR constraints. Second, conditional on observing her signal, the Receiver must prefer to take the prescribed action, which we call *second stage* IR constraints. The Sender's optimization problem with the revelation mechanism is then

$$\max_{\alpha(\mu),t(\mu)} \int_0^1 f(\mu)[\pi(\sum_{\omega\in\Omega} \Pr^S(\omega)\Pr(m(\omega)=H|\alpha(\mu)) + \mathbf{1}_{\alpha=0}\mathbf{1}_{\mu<\hat{\mu}}) + t(\mu)]d\mu$$

subject to

$$U(\alpha(\mu),t(\mu),\mu) \geq 0 \quad (2.1)$$

$$U(\alpha(\mu),t(\mu),\mu) \geq (1-\mu)u_H + \mu u_L \quad (2.2)$$

$$\Pr[\theta=H|\mu,m=B]\quad u_H + \Pr[\theta=L|\mu,m=B]u_L \geq 0 \quad (2.3)$$

$$\Pr[\theta=H|\mu,m=N]\quad u_H + \Pr[\theta=L|\mu,m=N]u_L \geq (1-\mu)u_H + \mu u_L \quad (2.4)$$

$$U(\alpha(\mu),t(\mu),\mu) \geq U(\alpha(\mu'),t(\mu'),\mu),\ \forall \mu' \in [0,1] \quad (2.5)$$

Note that in equation 2.4, $\Pr[\theta = H|\mu, m = N] = 0$, and so is trivially satisfied. Equation 2.3 can be seen as a "persuasion constraint," the $\alpha(\mu)$ offered to a Receiver must be large enough to induce her to choose B. However, if Equation 2.1 is satisfied, then

$$\begin{aligned}
(1-\mu)u_H + \mu(1-\alpha)u_L - t &\geq 0\\
(1-\mu)u_H + \mu(1-\alpha)u_L &\geq t\\
\frac{1-\mu}{(1-\mu)+\mu(1-\alpha)}u_H + \frac{\mu(1-\alpha)}{(1-\mu)+\mu(1-\alpha)}u_L &\geq \frac{t}{(1-\mu)+\mu(1-\alpha)}\\
&\geq 0,
\end{aligned}$$

which implies that 2.3 is satisfied.[4]

Given that the second stage IR constraints in Equations 2.3 and 2.4 are redundant, I can reduce the constraints to Equations 2.1, 2.2 and 2.5.

Proposition 11. *There exists a menu with a signal with $\alpha > 0$ that gives the Sender higher profits than an empty menu.*

[4] I ignore simultaneous violations in IC and second stage IR reasons because any such deviation automatically violates a first stage IR constraint.

To show this result, I identify a singleton menu that has higher profits than an empty menu. Consider increasing α while fixing $t = 0$, which has two impacts on the Sender's profits. First, pessimists close to the threshold Receiver $\hat{\mu}$, increasing α convinces them to accept the signal and be persuaded with some probability. However, for all optimists, an increase in α reduces the probability that they will be persuaded. Without imposing transfers for the signal, a sufficiently large mass of ex ante optimists may make offering these types of signals unprofitable. However, the Sender can use transfers to prevent optimistic Receivers from purchasing the signal. For small enough α, and t high enough, enough optimists can be dissuaded from purchasing the signal to make the profits gained from persuaded pessimists larger than the losses from optimists.

The driving assumption behind this result is that the distribution of types has full support on the interior. This guarantees that some small mass of pessimistic types can always be persuaded, yet transfers kept high enough to minimize inframarginal losses on optimists. If one were to examine a large discrete mass of optimists, with a small atomic mass of pessimists, the existence of a profitable persuasive menu does not hold, as persuasion gained from pessimists may not overcome inframarginal losses on the optimists.

The next theorem characterizes the optimal mechanism and shows that extreme belief types are not provided a signal, and that only finite number of signals is necessary to persuade a distribution of types.

Theorem 2. *For any optimal mechanism,*

1. There exist $\underline{\mu}$ and $\bar{\mu}$ such that $\forall \mu \in (\underline{\mu}, \bar{\mu})$, $\alpha^*(\mu), t^*(\mu) \neq 0$, and for $\forall \mu \in [0, \underline{\mu}) \cup (\bar{\mu}, 1]$, $\alpha^*(\mu) = t^*(\mu) = 0$.

2. The optimal mechanism pools Receiver types on a finite number of signals for a generic set of belief distributions f.

To show $\bar{\mu} < 1$, I first establish that if $\alpha(\mu) = 1$ then $t(\mu) > 0$, by showing that increasing t strictly increases the Sender's profits. This implies that there is some $\bar{\mu}$ for whom the first stage IR constraint in Equation 2.1 does not hold.

To show the second point, I divide the Sender's problem into two parts. First, the Sender chooses $\underline{\mu}$ and $\bar{\mu}$. Next, the Sender optimizes his profit subject to only offering signals to types within $[\underline{\mu}, \bar{\mu}]$. In the second part of the problem, I show that *any* choice of $\underline{\mu}$ and $\bar{\mu}$ will yield a menu with Receivers pooling on a finite number of signals.

This is a direct consequence of the linearity of both the Sender and the Receiver's utility functions with respect to the accuracy of the signal. For generic μ, either $\mu_0\pi > \mu u_L$ is satisfied, or not. That is, fixing Receiver type, the Sender can either extract more through transfer than he can through persuasion, or vice versa, as in Lewis and Sappington (1994). So, for each type, ignoring information rents, the Sender strictly prefers to either maximize or minimize the accuracy of the signal offered. For a generic $f(\mu)$, the information rents will not change these preferences, except at a finite number of points. Because these conditions are true for all but a finite number of types, the entire set is subject to the "bunching and ironing" procedure of Baron and Myerson (1982).

Finally, to show that $\underline{\mu} > 0$, examine the Sender's optimization problem when $\underline{\mu} = 0$. Given the finite pooling result, there is a pool that must include types in the neighborhood of $\mu = 0$. Because this signal must satisfy the $\mu = 0$ IR constraint, we require that the signal be offered for free. Conditional on offering the signal to this pool for free, the Sender's optimal signal is to set $\alpha = 0$. However, given that $\alpha(\mu)$ is zero for a neighborhood around $\mu = 0$, this violates our original assumption that $\underline{\mu} = 0$.

Basically, for optimistic types with μ close to zero, the marginal utility of accuracy in a signal is close to zero. Providing a signal for such types extends large informational rents to higher, more pessimistic types. Moreover, our assumption that $f(0) = 0$, along with differentiability, implies that the transfers to be extracted from optimistic Receivers vanishes as μ approaches zero. Thus for some mass of Receivers close to $\mu = 0$, the informational rents extended to higher types will outweigh the transfers that can be extracted. Note that because all optimists receive positive utility from any signal, the fact that the optimal menu excludes some optimists implies the Sender cannot be offering a signal for free.

2.5 Signals with Inefficient Costs

In many environments, the Sender lacks the ability to contract with the Receiver on the purchase of signals. In this section, the Sender can impose purely wasteful costs on the Receiver for signals. We construe these as costs This section examines how a Sender might The Sender's problem is as follows:

$$\max_{\alpha(\mu),t(\mu)} \pi \int_0^1 f(\mu)[\sum_{\omega\in\Omega} \Pr^S(\omega)\Pr(m(\omega) = H|\alpha(\mu)) + \mathbf{1}_{\alpha=0}\mathbf{1}_{\mu<\hat{\mu}}]d\mu$$

subject to the same constraints as before. Namely, Equations 2.1, 2.2 and 2.5 continue to hold, and Equations 2.3 and 2.4 continue to be redundant.

Property 3. *There exists a menu that gives the Sender higher profits than an empty menu.*

This is clear from the proof of Lemma 11. which shows that the Sender can profit from persuasion even when he is not allowed to implement transfers for his signals. The proof demonstrates that the essential component of profiting from persuasion is not that the Sender can extract the surplus of the signal, but that the transfers or costs enable the Sender to screen Receivers based on their heterogeneous utility for a given signal.

Lemma 6. *For any optimal mechanism,*

1. *There exist* $\underline{\mu}$ *and* $\bar{\mu}$ *such that* $\forall\mu \in (\underline{\mu}, \bar{\mu})$, $\alpha^*(\mu), t^*(\mu) \neq 0$, *and for* $\forall\mu \in [0, \underline{\mu}) \cup (\bar{\mu}, 1]$, $\alpha^*(\mu) = t^*(\mu) = 0$.

2. *The optimal mechanism pools Receiver types on a finite number of signals for a generic set of belief distributions* f.

The proof for this result closely mirrors its analogous result in the previous setting, and its proof is in the appendix. In the transfer setting, the Sender faces a three way tradeoff between transfer income, frequency of persuasion, and the persuasiveness of the messages. But in the obfuscation setting, only the latter two elements exist.

2.6 Sequential Transfers

In this section, I consider a setting where the Sender can condition the Receiver's transfer on the Receiver's action. Fixing a signal's accuracy, Receiver types have different ex ante beliefs about the probability that they will purchase the product after the signal. Thus a transfer that is contingent on the Receiver's action will have a different ex ante cost for different Receiver types, which can allow for more efficient screening from the Sender's perspective. As in Eso and Szentes (2007); Courty and Li (2000), I will examine contracts that condition on ex post outcomes to screen for the Receiver's ex ante beliefs.

I now allow the transfer function $t(\mu, a) \geq 0$ to account for the ability to condition the transfer on the Receiver's action. The Receiver's ex ante utility is now

$$U(\alpha, t, \mu) = (1-\mu)(u_H - t(\mu, B)) + \mu(1-\alpha(\mu))(u_L - t(\mu, B)) - \mu\alpha(\mu)t(\mu, N))$$

and the Sender's profit is

$$\Pi = \pi F(\underline{\mu}) + \int_{\underline{\mu}}^{\bar{\mu}} f(\mu)((\pi + t(\mu, B))[(1-\mu_0) + \mu_0(1-\alpha^*(\mu))] + \mu_0\alpha(\mu)t(\mu, N))d\mu$$

The individual rationality constraints of this problem are

$$U(\alpha, t, \mu) \geq 0 \tag{2.6}$$

$$U(\alpha, t, \mu) \geq (1-\mu)u_H + \mu u_L \tag{2.7}$$

$$\frac{(1-\mu)(u_H - t(\mu, B)) + \mu(1-\alpha(\mu))(u_L - t(\mu, B))}{1-\mu+\mu(1-\alpha(\mu))} \geq -t(\mu, N) \tag{2.8}$$

$$u_L - t(\mu, B) \leq -t(\mu, N) \tag{2.9}$$

and the incentive compatibility constraint is

$$U(\alpha(\mu), t(\mu, a), \mu) \geq U(\alpha(\mu'), t(\mu', a), \mu), \forall \mu' \in [0, 1]. \tag{2.10}$$

Equations 2.6 and 2.7 are the ex ante individual rationality contraints, while 2.8 and 2.9 are the constraints after the signal realization. Just as in the original setting, the first stage IR constraints imply the second stage constraints; 2.6 implies 2.8, and 2.8 implies 2.9. Namely, a Receiver would not purchase a signal if there did not exist some message that could induce him to change her action.

Theorem 3. *For any optimal mechanism,*

1. For any optimal mechanism, there exist $\underline{\mu}$ and $\bar{\mu}$ such that $\forall \mu \in (\underline{\mu}, \bar{\mu})$, $\alpha^*(\mu), t^*(\mu, a) \neq 0$, and for $\forall \mu \in [0, \underline{\mu}) \cup (\bar{\mu}, 1]$, $\alpha^*(\mu) = t^*(\mu, a) = 0$.

2. The optimal mechanism pools Receiver types on a finite number of signals for a generic set of belief distributions f.

3. For any optimal mechanism, there exists μ' such that $\forall \mu < \mu'$ $t(\mu, B) = 0$, and $\forall \mu > \mu'$, $t(\mu, N) = 0$.

The intuition for the first two points is analogous to those in previous settings. The informational rents extended to pessimists are large enough to justify exclusion of extreme optimists, who have a low marginal utility for accuracy. In the first two settings, the Sender prefers not to fully disclose the set for free, which carries over to this setting as well. Therefore, the Sender will also exclude extreme pessimists from a signal.

The third feature of the optimal mechanism pertains to when the Sender would prefer to charge the Receiver, and for which actions. If $\mu < \mu_0$, then the Receiver is more optimistic than the Sender. Fixing a signal's accuracy, the Sender's profit increases to maximize $t(\mu, N)$ subject to the IC and IR constraints. No first stage IR constraint binds for the Receivers, so for interior $\mu < \mu_0$, the Sender has increased $t(\mu, N)$ until IC binds. A similar argument can be made for $\mu > \mu_0$.

Given the difference in ex ante opinion, the Sender would ideally prefer to bet with the Receiver directly over the state realizations. However, in many contracting settings the state is nonverifiable and thus not contractible, the Sender instead contracts on the Receiver's action. Like in Eliaz and Spiegler (2009), the individual rationality constraints of the Receiver in the second stage limit the stakes of the implementable contract.

2.7 Discussion

The structure of the optimal menu combines several key insights from the heterogeneous priors, sequential screening, and information disclosure literatures.

In all of the pricing settings examined, although persuasion is always profitable for the Sender as in Kamenica and Gentzkow (2011), not all types receive a signal. This leads to underprovision of information to extreme pessimists, and overprovision to extreme optimists, in a manner resembling the under and overprovision of goods in Courty and Li (2000). The second stage individual rationality constraint prevents inclusion of extreme pessimists, and the Sender excludes optimists to avoid extending information rents to pessimists.

Fixing a Receiver type, the Sender would either strictly prefer to give her the least informative signal to persuade her to take the action, or strictly prefer to fully disclose the state and extract profits through transfers. This limited scenario resembles the stark disclosure results of Lewis and Sappington (1994). However, the use of transfers and money-burning to separate Receiver types based on beliefs can yield more than one available signal for Receivers because the Sender may wish to pool optimistic types at lower accuracy levels in order to avoid extending rents to pessimistic types. The sequential screening contracts from Section 2.6 allow the Sender to further mitigate the tradeoff between message persuasiveness and frequency that the Sender faces. Heterogeneity in beliefs gives each Receiver a different ex ante cost for each signal and product price pair, which increases the Sender's ability to screen Receiver types.

Although this model is limited to a binary state, binary action case, one might ask to what extent these results extend to a more general setting with more actions and states. Alonso and Camara (2013) show that heterogeneity in Receiver priors enhances the ability of Senders to persuade a Receiver. By exploiting heterogeneity in Receiver beliefs over three or more states, they show that Senders' payoffs need not be convex in the Receiver's posterior. The construction of the singleton signal in their model suggests that it is possible to screen Receivers purely through the design of the signals, without transfers, costs, or the traditional screening tools of mechanism design.

Chapter 3

Why People Vote: Ethical Motives and Social Incentives

3.1 Introduction

Understanding why people vote is fundamental to the theory and practice of democracy. Analyses rooted in rational choice face difficulty in explaining why so many people incur the cost of voting even when it is improbable that any one of them is pivotal. An obvious shortcoming of pivotal-voter models is that it restricts voter motivations to be purely instrumental in terms of affecting the electoral outcome to the exclusion of motives rooted in civic duties, ethics, the desire to have voice, social norms, and social pressures. The evidence on voter motivations and turnout calls for alternative theories of why people vote;[1] this paper offers a framework that unifies ethical motives and social incentives to vote.

Our starting point is the paradigm of *expressive voting*, which assumes that voters derive satisfaction from fulfilling their civic duties. Early incarnations of such models (e.g. Riker and Ordeshook, 1968) modeled the act of voting as having a constant consumption value for those who vote, which rationalizes voting without explaining why turnout varies across elections. Recent contributions have addressed this issue by imposing greater structure on what duty entails: in the *ethical voter* framework, some citizens are rule-utilitarian and so vote according to the rule that is optimal for their group to follow. Harsanyi (1980) initially proposed this framework in an election with common interests, and Feddersen and Sandroni (2006*a*,*b*,*c*) generalize it to elections with competing political interests; importantly, they show that linking civic duties to the primitives of an election can generate aggregate turnout that is responsive to voting costs, the importance of the election, and the expected closeness of the race.[2]

The ethical voter framework is useful to understand turnout but is silent about social mechanisms and pressures that are widely believed to drive voting, and have been the focus of a growing empirical literature. For example, Gerber, Green and Larimer (2008) find that informing voters in the 2006 Michigan Primary that

[1] See Feddersen (2004) for a survey of the theoretical literature on turnout.

[2] Coate and Conlin (2004) develop a model based on this approach and structurally estimate Texas liquor referenda, and Abhijit Banerjee, Selvan Kumar, Rohini Pande and Felix Su (2011) use an ethical voter framework to interpret how voters in India respond to information about political candidates. A separate literature has modeled ethical voters as being *act utilitarian* and altruistic; I discuss this in conclusion.

their neighbors will be told whether they voted increases turnout among registered voters from 29.7% to 37.8%, garnering an increase greater than most campaign mobilization strategies. Funk (2010) finds similar evidence in Switzerland in which optional postal voting was adopted sequentially across cantons, which reduced voting costs substantially and yet failed to significantly increase aggregate turnout and in fact decreased turnout in small communities. As discussed by Funk (2010) and others,[3] these findings offer evidence towards social incentives since postal voting is less visible than voting at the polls.

Social pressures and signals have been at the core of many real-world mechanisms designed to mobilize turnout. "Name-and-shame" systems in which the names of non-voters were publicly displayed were common in the nineteenth century, remained in Italy until 1993, and continue in some form today across the world.[4] Communities and religious organizations often use campaign mobilization strategies that induce individuals to vote in groups so as to ensure visibility. All of these mechanisms suggest that the *visibility* of the act of voting is an important motivator of turnout; it is perhaps less than surprising that it would be, especially since the importance of social esteem and extrinsic incentives for "good behavior" has been established in many domains, including giving behavior, organizational economics, and political economy.[5]

Our perspective is that rather than modeling ethical and social motivations as being orthogonal, it is useful to integrate these two frameworks while maintaining simplicity and tractability. Ethical voting offers a useful and necessary anchor for social pressure; indeed, while the importance of extrinsic motives and social pressure in turnout decisions has been discussed extensively (e.g. Knack, 1992; Shachar and Nalebuff, 1999; Grossman and Helpman, 2002), its form has

[3] For example, see Dubner and Levitt (2005) and Bénabou and Tirole (2006).

[4] For example, in Singapore, the punishment for not voting is to be declared ineligible to vote in the future unless one pays a fine; Singapore's Elections Department makes publicly available the list of citizens who are eligible to vote, thereby allowing citizens to infer who did not vote. Voting history is public record in the United States, and in certain contexts, easily available electronically (e.g. on http://www.whovoted.net); Birch (2009) discusses these institutions. We thank Justin Valasek for suggesting these examples.

[5] See Bernheim (1994), Harbaugh (1998), Bénabou and Tirole (2006), Ellingsen and Johannesson (2008) Andreoni and Bernheim (2009), Ariely, Bracha and Meier (2009), and DellaVigna, List and Malmendier (2011).

lacked an explicit description. Models with reduced-form rewards and sanctions for voting fail to capture why it is that turnout should depend on its expected closeness or its importance and do not elucidate the source of social motivation. Complementing ethical voter models with social pressure shows that the ethical voting framework is both useful even if all voters are not intrinsically motivated by ethics, and can speak to the role of social mechanisms and visibility in fostering turnout. Accordingly, we study a model in which some voters are *extrinsically motivated* to vote because they wish to *appear intrinsically motivated*.

Our basic setting is an election in which each of two opposing groups have a continuum of citizens, each of whom finds voting costly. Citizens in each group are either *ethical* or *pragmatic*. An ethical citizen is group-utilitarian: she follows the rule that maximizes the social welfare of her group given the behavior of others. A pragmatic citizen (henceforth pragmatist) votes only because she wishes others to think of her as being ethical. We show that a profile of action rules exists in which every citizen—ethical and pragmatic—is optimally responding to the aggregate population; we call any such profile a *political equilibrium*. In a political equilibrium, the ethical citizens in a group follow the rule that best-responds to the ethical citizens in the other group and the pragmatists in each group; analogously, a pragmatist decides whether to vote based on the gain in *social image* from voting, which is derived from the equilibrium participation rates of ethical and pragmatic citizens. Thus, ethical and pragmatic citizens are influenced by the behavior of the other in a political equilibrium. We characterize political equilibria and show that in many settings, there is a unique political equilibrium.

Our analysis of political equilibria reveals a number of interesting features of turnout. Because a pragmatist's motive for voting is to influence how others see her, she has weaker incentives to vote when there is little ex ante uncertainty about her type. Therefore, social incentives alone cannot motivate turnout. Interpreting the evidence for social incentives towards social image (as is often done) implies that citizens must consider there to be a substantial fraction of both ethical and pragmatic citizens.

Anchoring social incentives to ethical motivations permits the framework to capture the *competitive predictions* at the core of ethical voter models: because ethical citizens vote more with increases in the importance of the election or its expected margin of victory and with decreases in the voting costs, so do pragmatists, and thus, *all citizens* respond to these changes. Unlike ethical citizens, pragmatists respond to the visibility of their vote, and hence, are further inclined to vote when their choice is observable to neighbors, when voting is at a public polling location, or when there is information that is shared publicly about the importance of an election. Thus, the framework straightforwardly captures many of the predictions attributed to voter turnout.

While the participation of pragmatists is increasing in that of ethical citizens, ethical citizens decrease their participation in response to a larger turnout from pragmatists in their group: in effect, ethical citizens attempt to compensate for the lower turnout of pragmatists and so a greater turnout from pragmatists dampens their motive to vote. Thus, if the social incentives to vote differ across two groups, ethical citizens in the group with stronger social incentives will have a lower cutoff than those in the weaker group, but nevertheless the group with stronger social incentives wins the election with greater likelihood.

The role that social incentives play in turnout may raise the concern that excessive social pressure could distort individual incentives towards *too much* voting. This tension manifests in other settings: for example, Bénabou and Tirole (2006) and Daughety and Reinganum (2010) both demonstrate that too much social pressure can induce "pro-social behavior" and public good contributions that are excessively high and socially inefficient.[6] Unlike these settings, social pressure <u>never</u> induces over-voting: if a pragmatist votes, she does so only at costs that the ethical citizen in her group would also do so. The force that countervails "over-voting" is that were it to arise, abstention would induce a more favorable equilibrium image than voting in which case no pragmatist would vote.

We believe that integrating conceptions of social duties and pressures helps illustrate the role that communities play in turnout.[7] A number of studies highlight

[6]Similar issues arise when agents have extrinsic motives or career concerns and are privately informed about the right action to take as highlighted by Levy (2007), Prat (2005), and Visser and Swank (2007).

[7]Putnam (2000) argues that the decline in political participation in the United States has

how differences in community participation rates correlate with other characteristics of the community, and the literature points to the importance of frequent interactions and *social connectedness* as discussed by Grossman and Helpman (2002):

> "All of these observations point to "social connectedness" as an important predictor of voter turnout. Individuals who are part of groups that meet frequently and interact intensively should be more likely to vote than those who are socially isolated or who belong to loosely linked groups...."

Towards understanding the role of social connectedness, we discuss two extensions in which we enrich the informational setting. First, we investigate behavior when pragmatists may lie about whether they have voted, but such lies may be detected by others in the community. Second, we study turnout when individuals may possess some information about the voting costs of others. In both of these settings, we find that richer information induces greater aggregate turnout and offers a starting point to understand why tightly-knit groups in which individuals meet frequently have greater turnout than others.

We also consider an extension in which the notion of pragmatists is more closely matched to independent citizens who need not be affiliated with a particular group, but can choose which group to join to maximize their social rewards. Such an extension helps understand *neighborhood effects* in which an individual's political affiliation is influenced by the strength and nature of political groups and social networks in her neighborhood.[8] Endogenous affiliation introduces a *stability* condition that a pragmatist could not have gained in social image from having decided to join a different group than that which she joins in equilibrium. We show that the analogue of a political equilibrium continues to exist and is essentially unique. Interestingly, with endogenous affiliation, asymmetries across the two groups in their social incentives or value of the election do not manifest in the behavior of pragmatists across the two groups but in their ability to attract

followed a decline in social ties; similarly Alesina and Ferrara (2000) finds that inequalities in communities reduce voter participation.

[8]Neighborhood effects have been described in prominently in a number of different contexts, e.g. Lazarsfeld, Berelson and Gaudet (1944), Campbell (1980), Kenny (1992), and Mutz (2002).

pragmatists. In equilibrium, both groups offer the same social rewards, but the group that offers a greater marginal payoff from social image attracts more voters.

Our final application is to study the implications that electoral competition has for turnout and platform selection. In practice, candidates select platforms to influence not only *how* people vote, but also *who* votes; this has been widely recognized in academic and media analyses, and is an issue that looms large in political rhetoric.[9] Yet, in most models of electoral competition, voting is costless thereby obscuring this motive that candidates may have to pander to groups that are able to effectively mobilize turnout.[10] In a stylized setting, we show that candidates motivated purely by office converge to a common platform ensuring no turnout while policy-motivated candidates diverge ensuring some turnout. In both cases, asymmetries across the two groups creates a motive to pander towards those who are more responsive to policy or have stronger social incentives.

The proofs for the basic framework described in Section 3.2 are in the Appendix, but those for all other sections are in the Supplementary Appendix.

3.2 The Basic Model: Ethicals and Pragmatists

3.2.1 Environment

We build on Feddersen and Sandroni (2006*a*,*c*): each citizen of a continuum decides whether to vote for alternative 1, alternative 2, or abstain, and the winner of the election is determined by majority rule. Citizens belong to one of two groups, 1 and 2, and those who belong to group 1 prefer that alternative 1 win, and others prefer that alternative 2 wins. Voting by citizen i for alternative i is denoted by

[9] A salient illustration of this effect is the extent to which candidates pander on issues of Social Security and the cost of prescription drugs in their platforms to the greater turnout of the elderly, as noted by Campbell (2003). Similarly, in both developed and developing countries, the importance of lower-class mobilization for political redistribution is widely noted and studied (e.g. Hill, Leighley and Hinton-Andersson, 1995; Varshney, 2007).

[10] A few models have studied the interaction of turnout and electoral competition—Glaeser, Ponzetto and Shapiro (2005) and Virág (2008), study political extremism when platforms are not publicly observed, and Valasek (2011) studies the interplay of electoral competition and voting costs in an ethical voter framework—but none to our knowledge have focused on this motive to pander towards the social incentives of particular groups.

$a_i = 1$ and abstention is denoted by $a_i = 0$. The cost of voting for citizens is distributed according to cdf F whose pdf, f, is continuous and strictly positive on $[0, \infty)$.[11]

Citizens are uncertain about the relative size of each group: the fraction of citizens in group 1, denoted by k, is a random variable with support $[0, 1]$ and governed by a symmetric Beta distribution with parameter α. The beta distribution encompasses both the uniform distribution ($\alpha = 1$) and those that are single-peaked around $\frac{1}{2}$ ($\alpha > 1$). Instead of using the expression for the density of k in our analysis,[12], it is simpler to formulate probabilities in terms of $x = \dfrac{k}{1-k}$, whose density denoted by h is

$$h\left(x, \alpha\right) = \frac{x^{\alpha-1}}{(1+x)^{2\alpha} B(\alpha, \alpha)},$$

in which $B(\alpha, \alpha)$ is the Beta function. For expositional convenience, we suppress the dependence of h on α and use $H\left(x\right)$ to denote its cdf.

Citizens are either ethical ($t_i = E$) or pragmatic ($t_i = P$): the fraction of ethical citizens in each group is q in $(0, 1)$. We describe voter motivations in greater detail below.

3.2.2 Voter Motivations

An ethical citizen votes according to the rule that maximizes his perception of social welfare, even though he recognizes that his own vote is not pivotal in this large election. Each citizen believes that the collective gain is w when his preferred candidate wins, which denotes the *importance of the election*, and prefers for aggregate voting costs to be minimized. Assuming that every citizen is ethical, and holding fixed the behavior of pragmatists and the other group, the ethical rule specifies the utilitarian optimal decision rule, which necessarily takes the form of a

[11]Introducing an upper-bound on voting costs does not affect the analysis but requires more notation.

[12]The density of k being a symmetric Beta distributed random variable is $\dfrac{k^{\alpha-1}\left(1-k\right)^{\alpha-1}}{\int_0^1 \tilde{k}^{\alpha-1}\left(1-\tilde{k}\right)^{\alpha-1} d\tilde{k}}$.

threshold rule: an ethical citizen i in group G votes if and only if $c_i \leq c_G^*$ for some cost c_G^*.

A pragmatist, in contrast to the ethical citizen, recognizes that her vote is not pivotal in the electoral outcome, but that it is pivotal in how she is perceived by others (insofar as ethical individuals are esteemed). Her payoff from taking action a_i is

$$-c_i a_i + \lambda \Pr\left(t_i = E|a_i\right).$$

The second term represents her social esteem, in which the coefficient $\lambda > 0$ represents the marginal payoff from social image. Naturally, this coefficient reflects both her image-payoffs and the probability with which her act of voting is observed by others in her group.[13]

Image is attributed to citizens' actions via Bayes' rule. The payoff induces a threshold $\hat{c}_G$ such that a pragmatist citizen i in group G votes if and only if $c_i \leq \hat{c}_G$. Suppose that the expected cutoff for ethical citizens in group G is c_G^*.[14] The perception of a citizen's moral type denoted by $\zeta\left(a, \hat{c}_G, c_G^*\right)$ is

$$\zeta\left(a, \hat{c}_G, c_G^*\right) = \frac{qF\left(c_G^*\right)}{qF\left(c_G^*\right) + (1-q)F(\hat{c}_G)} \qquad if a = 1, \tag{3.1}$$

$$\frac{q(1-F\left(c_G^*\right))}{q(1-F\left(c_G^*\right)) + (1-q)(1-F(\hat{c}_G))} \qquad if a = 0. \tag{3.2}$$

Implicit in the above equation is that a citizen's type is assessed according to the relative participation rates of ethical citizens and pragmatists in her group alone. Our assumption that a citizen's affiliation is known is motivated by homophily (McPherson, Smith-Lovin and Cook, 2001; Currarini, Jackson and Pin, 2009): peers from whom one wishes to gain approval are likely to belong to the same group, and hence, judge one's actions based on behavior within that group. Political polarization reinforces these incentives: pragmatists may be valued on

[13] Voting may be directly observed when communities coordinate on voting or register together, as they often do. In other contexts, it may be spread by word-of-mouth communication through the social network in the community.

[14] We establish below that as in the prior literature, the ethical rule takes the form of a threshold strategy.

the basis of showing loyalty to their particular group rather than to the entire electorate.[15]

A pragmatist with the threshold cost is necessarily indifferent between voting and abstaining, and so this cost offsets the pragmatist's gain in social esteem from voting:

$$\lambda \left(\zeta \left(1, \hat{c}_G, c_G^* \right) - \zeta \left(0, \hat{c}_G, c_G^* \right) \right) = \hat{c}_G. \tag{3.3}$$

For each value of c_G^*, we let $P\left(c_G^*\right)$ denote a solution (if any exists) to the above equation.

Definition 1. *For an ethical cutoff, c_G^*, a cutoff for pragmatists $\hat{c}_G$ is a* ***Pragmatic Best Response*** *if $\hat{c}_G = P\left(c_G^*\right)$.*

Before turning attention to ethical citizens, we highlight useful properties of P.

Lemma 7. *The Pragmatic Best Response exists, is unique, and is strictly increasing in c_G^*.*

The argument for uniqueness is straightforward: the marginal gain in social image from voting for a pragmatist in group G is strictly decreasing in $\hat{c}_G$ because when pragmatists vote in greater number, they sully the image of voting and improve that of abstaining. In contrast, more voting by ethical citizens strengthens the signaling incentives of pragmatists and hence increases the Pragmatic Best Response.

As the pragmatists respond to their expectations of how ethical citizens behave, ethical citizens respond to their expectations of pragmatists' participation. For pairs of cutoffs for ethical citizens, (c_1, c_2), and pragmatists, $(\hat{c}_1, \hat{c}_2)$, the

[15] In the symmetric setting, results are necessarily identical if we assumed alternatively that a citizen's political affiliation is unknown, and hence, her image is determined using the fraction of ethicals in both groups. However, if groups are asymmetric, slightly different results follow when citizens' affiliations are unknown.

expected social cost of voting is

$$\begin{aligned}\phi\left(c_1, c_2, \hat{c}_1, \hat{c}_2\right) =&E[k]\left(q\int_0^{c_1} cdF + (1-q)\int_0^{\hat{c}_1} cdF\right)\\ &+ (1-E[k])\left(q\int_0^{c_2} cdF + (1-q)\int_0^{\hat{c}_2} cdF\right).\end{aligned}$$

Accordingly, the aggregate welfare as perceived by ethical citizens in each group is

$$\begin{aligned}V_1\left(c_1, c_2, \hat{c}_1, \hat{c}_2\right) =&w\left(1 - H\left(\frac{qF\left(c_2\right) + (1-q)F\left(\hat{c}_2\right)}{qF\left(c_1\right) + (1-q)F\left(\hat{c}_1\right)}\right)\right) - \phi\left(c_1, c_2, \hat{c}_1, \hat{c}_2\right),\\ V_2\left(c_1, c_2, \hat{c}_1, \hat{c}_2\right) =&wH\left(\frac{qF\left(c_2\right) + (1-q)F\left(\hat{c}_2\right)}{qF\left(c_1\right) + (1-q)F\left(\hat{c}_1\right)}\right) - \phi\left(c_1, c_2, \hat{c}_1, \hat{c}_2\right).\end{aligned} \tag{3.4}$$

The optimal ethical rule for each group is the cutoff c_G^* which, holding all else fixed, maximizes V_G. This notion of *consistency*, offered by Coate and Conlin (2004) and Feddersen and Sandroni (2006*a*,*b*,*c*), is adapted to our setting in which non-ethical citizens vote:

Definition 2. *A profile* (c_1^*, c_2^*) *is a* ***Consistent Ethical Response*** *to* $(\hat{c}_1, \hat{c}_2)$ *if for every group* G,

$$V_G\left(c_G^*, c_{-G}^*, \hat{c}_1, \hat{c}_2\right) \geq V_G\left(c, c_{-G}^*, \hat{c}_1, \hat{c}_2\right) \text{ for all } c > 0.$$

3.2.3 Political Equilibrium

Based on the voter motivations described in the prior section, we describe the appropriate solution-concept: pragmatists in each group hold correct beliefs about the behavior of ethical citizens and best-respond based on their signaling motives, and given the beliefs (and behavior) of pragmatists, ethical citizens in each group prefer to not deviate to an alternative ethical rule.

Definition 3. *A* ***Political Equilibrium*** *is a profile of thresholds* $\left\{\left(c_1^*, c_2^*\right), \left(\hat{c}_1, \hat{c}_2\right)\right\}$ *such that:*

1. (c_1^*, c_2^*) *is a Consistent Ethical Response to* $(\hat{c}_1, \hat{c}_2)$
2. $(\hat{c}_1, \hat{c}_2)$ *are Pragmatic Best Responses to* (c_1^*, c_2^*).

We first show that a political equilibrium exists and is unique. Based on the pragmatists' cutoffs, $(\hat{c}_1, \hat{c}_2)$, one can derive the Consistent Ethical Response by examining the two first-order conditions from Equation 3.4 with respect to c_1 and c_2; comparing the two reveals that at the optimum

$$c_1^* \left(qF\left(c_1^*\right) + (1-q)\,F\left(\hat{c}_1\right)\right) = c_2^* \left(qF\left(c_2^*\right) + (1-q)\,F\left(\hat{c}_2\right)\right). \tag{3.5}$$

Since in equilibrium, $\hat{c}_G = P\left(c_G^*\right)$ and P is strictly increasing, it follows that $c_1^* = c_2^*$. Substituting this symmetry into the FOC and verifying that the SOC is satisfied demonstrates existence and uniqueness.

Theorem 4. *There is a unique political equilibrium: for every group G, c_G^* solves*

$$c_G^* \left(qF\left(c_G^*\right) + (1-q)\,F\left(P\left(c_G^*\right)\right)\right) = \frac{2^{1-2\alpha}w}{B\left(\alpha,\alpha\right)}. \tag{3.6}$$

Using this expression, we describe various properties of the unique political equilibrium. Since the LHS is increasing in c_G^*, changes in parameters that monotonically change the value on the RHS must have the same effect on the political equilibrium. The term w captures the importance of the election and α offers a metric for its competitiveness[16]. Finally, voting cost distributions can be ranked by first-order stochastic dominance; we say that voting costs decrease if the resulting distribution is dominated by the initial distribution.

Property 4 (Competitive Effects)**.** *The participation rate of all citizens is increasing in the importance and competitiveness of the election, and as voting costs decrease.*

This property highlights how political equilibrium captures competitive aspects of an election without predicating behavior on an individual's pivot considerations. Our solution-concept inherit this property directly from its ethical voter foundations, and analogous results without social signaling are derived by Feddersen and Sandroni (2006*a*). The intuition is straightforward: as the election becomes more important or competitive, ethical types in each group consider it

[16] Increasing α shifts probability mass for k from the tails and concentrates it around the peak of 1/2 (where the election is close)

more important to vote, and this spurs the pragmatists to also vote in greater numbers. When costs decrease, the marginal cost of increasing turnout from the standpoint of the consistent rule decreases, and so the participation rate of ethical citizens rises. Holding the pragmatists' participation rate fixed, the greater participation of ethical citizens increases the gap in social image between voters and abstainers. Therefore, in a political equilibrium, the participation rate of pragmatists necessarily increases.

Our next set of properties describe the signaling incentives in the framework. The term λ includes a number of concerns relevant for pragmatists, including the observability of voting, the impact of social image, the social rewards attached with being perceived as ethical or loyal, and the sanctions of being perceived as non-ethical. Its changes can therefore be attributed to variations in the observability of voting (Gerber, Green and Larimer, 2008; Funk, 2010), or the role of group leaders in generating social pressure (Shachar and Nalebuff, 1999).

Property 5. *An increase in social incentives decreases the participation rate of ethical citizens but increases the participation rate of pragmatists and the average participation rate.*

That the participation of pragmatists increases with social incentives is intuitive but the more subtle effect is that of social incentives on ethical citizens. With stronger social incentives, ethical citizens are less motivated to compensate for pragmatists and therefore decrease their participation. This is one form in which extrinsic motivation *crowds out* intrinsic motivation: stronger social incentives skews the composition of voters towards those who are more extrinsically motivated and abstainers towards those who are more intrinsically motivated. Overall voter participation nevertheless increases with social incentives.

That turnout is increasing in extrinsic motivation invites a concern: perhaps social pressure could induce more turnout than that which would be ethical. Such inefficiencies emerge generally in other settings (as described in the introduction) but are precluded in our framework.

Property 6 (No Overvoting)**.** *Regardless of the strength of social incentives, pragmatists in group G vote only at costs that an ethical voter also does so: $\hat{c}_G < c^*_G$.*

The mechanism for Property 6 is simple: as $\hat{c}_G \to c^*_G$, the gain in social image from voting is vanishing. Indeed, if pragmatists voted more than ethical citizens, abstention rather than voting would be a better signal that one is ethical, in which case pragmatists should not be voting at all (since they are effectively taking a costly action that only tarnishes their image). Accordingly, as $\lambda \to \infty$, the pragmatists' cutoff approaches from below that of ethical citizens thereby dissolving the gap in image between voters and abstainers.

We now demonstrate that having a non-trivial fraction of ethical citizens is indispensable for this analysis. For signaling incentives to motivate voting, citizens must expect that they can influence their image through voting and if the prior probability of being an ethical citizen is sufficiently small, pragmatists have weak incentives to vote.

Property 7. *As $q \to 0$, the participation rate among ethical citizens converges to full participation ($F(c^*_G) \to 1$), but overall turnout is nevertheless vanishing.*

That signaling incentives are weak when there is little ex ante uncertainty is analogous to our understanding of reputation in other contexts; reputation effects are dramatic when a long-run player considers the undiscounted sum (Kreps and Wilson, 1982) or approaches perfect patience (Fudenberg and Levine, 1992), but for a fixed discount factor, reputation effects disappear as the prior belief on types converges to probability 1 on the rational type. Similar to the no discounting limit, if λ is arbitrarily large, even a small probability of ethical citizens suffices to induce substantial turnout, but if λ is bounded, then reputational incentives require a non-trivial fraction of ethical citizens. We view this property as important to our understanding of the complementarity of ethical and social motives to vote.

The final set of properties that we discuss depart from symmetry. A challenge in studying asymmetric groups is that a political equilibrium may no longer exist or be unique when it does. We show in the Supplementary Appendix that if k is uniformly distributed on $[0, 1]$, a unique political equilibrium exists;[17] with this restriction, we describe how asymmetries between the ethical citizens in the

[17] Feddersen and Sandroni (2006*c*) offer conditions for existence and uniqueness of consistent rule profiles in the setting without social incentives.

two groups affect the unique political equilibrium.

Property 8. *When the election is more important to group* 2 *than it is to group* 1 *($w_2 > w_1$), or group* 2 *has a lower distribution of voting costs (F_1 first-order stochastically dominates F_2), then the participation rates of both ethical citizens and pragmatists are higher in group* 2 *than in group* 1*. Therefore, group* 2 *has a higher probability of winning the election.*

The above property is intuitive, but also highlights the political gain from subsidizing turnout as well as introducing ballot propositions that one group may consider more important than the other.

With asymmetric social incentives—suppose $\lambda_1 < \lambda_2$—the Pragmatic Best Response for group 2 (denoted by P_2) exceeds that for group 1 (denoted by P_1) for every ethical cutoff, c^*. An analogue of Equation 3.5 holds whose implication is

Property 9. *When group* 2 *has stronger social incentives than group* 1*, ethical citizens in group* 2 *participate less than ethical citizens in group* 1*. Nevertheless, the average participation rate in group* 2 *is higher, and therefore, group* 2 *has a higher probability of winning the election.*

The above result is analogous to the *underdog effect*: when group 1 has weaker social incentives, its ethical citizens participate more to compensate for the rest of their group, although it is not sufficient to overcome group 2's aggregate turnout. Because ethical citizens in group 1 participate more than those in group 2 and pragmatists in group 1 participate less than those in group 2, the image gap between voters and abstainers is higher in group 1. Thus, those who participate in group 2 are more likely to be motivated by social rewards than voters in group 1.

3.3 Extensions

This section explores several extensions to our framework. We study the role of community monitoring in fostering turnout: Section 3.3.1 allows for the possibility for individuals to lie about voting, and examines how turnout varies with the probability with which communities foster hard information about voting decisions; **??** studies a different setting in which communities vary in the extent to which their members know the voting costs of other members. Section 3.3.3 analyzes behavior when pragmatists can choose which group to join. Section 3.3.4 discusses other extensions in which ethical behavior may be less sophisticated about each group's distribution of ethics, and individuals may vary as to how ethical they are along a continuum.

3.3.1 Votes and Lies

The social incentive to vote comes from persuading others that one is ethical, which invites an important question: why do pragmatists vote at all when they can lie about voting? That reported turnout (to pollsters) exceeds actual turnout suggests that voting is socially rewarded. Yet, a pragmatist may find it more difficult to lie about voting to others in one's community, especially if voting and registration in that community are organized in groups. Information diffuses quickly in tightly-knit communities and so in concocting a voting experience, an abstainer may reveal that he has not voted and in lying, revealed his type. In contrast, when voting, a citizen may be seen by others (or choose to vote when others are doing so) in which case the hard evidence speaks in favor of his type. We investigate the interplay of lying and signaling incentives in turnout.[18]

Suppose that once a voter chooses whether to vote, a perfectly informative signal of her action is revealed to others with probability s and with complementary probability, no external signal is generated. Prior to this signal being generated but after she has chosen whether to vote, a citizen can communicate via a cheap-talk message to members of her community about her choice. We assume that ethical citizens follow the ethical rule, and reveal their decisions truthfully. Others

[18] Harbaugh (1996) studies these issues in a setting in which individuals vote because they enjoy receiving praise and dislike lying whereas some others prefer to lie, and a third category of people admit that they did not vote. Our model derives the value of praise or sanctions endogenously in equilibrium. Stefano DellaVigna, John List, Ulrike Malmendier and Gautum Rao (2011) find evidence through a novel field experiment design that individuals who abstain are averse to discussing their political participation; this evidence indicates that individuals are motivated to vote so as to avoid having to tell others that they abstained or lie about it.

assess a citizen's type by the message that she sends and hard information about her action if any such information is revealed.

Towards finding the Pragmatist Best Response in this setting, let c_G^* and $\tilde{c}_G$ denote the threshold cost cutoffs used by ethical citizens and pragmatists respectively. For a pragmatist that abstains, the payoff from lying is invariant to her voting cost; μ_G denotes the fraction of pragmatists that falsely claim to vote.[19] A voter thus expects a social image of

$$s\frac{qF\left(c_G^*\right)}{qF\left(c_G^*\right)+(1-q)\,F\left(\tilde{c}_G\right)}+(1-s)\,\frac{qF\left(c_G^*\right)}{qF\left(c_G^*\right)+(1-q)\left(F\left(\tilde{c}_G\right)+\mu_G\right)}, \tag{Voter's Image}$$

in which the first term is the social image when hard information is revealed proving that the voter voted, and the second term is the image relying on cheap-talk alone. A citizen who abstains and admits this to others has a social image of

$$\frac{q\left(1-F\left(c_G^*\right)\right)}{q\left(1-F\left(c_G^*\right)\right)+(1-q)\left(1-F\left(\tilde{c}_G\right)-\mu_G\right)}. \tag{Truthful Abstainer's Image}$$

Finally, a citizen who abstains but claims to vote expects an image of

$$s(0)+(1-s)\,\frac{qF\left(c_G^*\right)}{qF\left(c_G^*\right)+(1-q)\left(F\left(\tilde{c}_G\right)+\mu_G\right)}. \tag{Lying Abstainer's Image}$$

In understanding behavior, it is helpful to begin with the case without hard information ($s=0$): no pragmatist ever votes but a positive fraction claims to vote. Yet, a positive fraction must also confess to abstention for otherwise this message would be sent by only ethical citizens and then command the greatest social esteem. In equilibrium, the fraction of pragmatists that claims to vote equates the fraction of ethical citizens that votes so that a citizen's social image is invariant to what she tells others.

Greater monitoring induces more voting and truth-telling from pragmatists. In equilibrium, a pragmatist who abstains is truthful with positive probability for the reason described above,[20] and so must randomize between lying and telling the

[19]While in principle, a pragmatist could vote and lie that she abstained, she has no reason to do so in equilibrium, and so we ignore this case.

[20]The underlying principle is akin to that which drive experts in Dziuda (2011) to reveal unfavorable information: when an "honest" type sometimes takes an unfavorable action, an imitating strategic type has a strong signaling motive to pool.

truth if she lies at all. We define the Pragmatic Best Response in this setting as follows

Definition 4. *For an ethical cutoff, c^*_G, the Pragmatist Best Response is a vector $(\tilde{c}_G, \mu_G)_{G=1,2}$ such that:*

1. *A pragmatist citizen with cost below $\tilde{c}_G$ votes and reveals this truthfully to others.*
2. *Pragmatists with costs above $\tilde{c}_G$ abstain; the fraction of these that claims to vote is μ_G.*
3. *For every G, $\tilde{c}_G = \lambda\Big(\text{Voter's Image} - \text{Truthful Abstainer's Image}\Big)$.*
4. *If $\mu_G > 0$, then Truthful Abstainer's Image = Lying Abstainer's Image.*

We show in the Supplementary Appendix that for every c^*_G, the Pragmatist Best Response exists and is unique.[21] Since pragmatists' behavior varies with s, so does the Consistent Ethical Response.

Theorem 5. *There is a unique political equilibrium in which for every group G,*

$$c^*_G \left(qF\left(c^*_G\right) + (1-q)\,F\left(\tilde{c}_G\right)\right) = \frac{2^{1-2\alpha}w}{B\left(\alpha,\alpha\right)}.$$

The participation rate of all citizens and pragmatists in each group is increasing in s while that of ethical citizens is decreasing in s. The fraction of pragmatists that falsely claim to vote in each group, μ_G, is decreasing in s and there exists $\tilde{s} < 1$ such that $\mu_G = 0$ for every $s > \tilde{s}$.

This result illustrates how aspects of our basic model extend to accommodate lying: when citizens are concerned that lies may be detected by others, some of them vote for the sake of social image. With improvements in monitoring, pragmatists have a stronger incentive to vote and thus, ethical citizens (as in Property 5) have less of an incentive to vote; on net, average turnout increases. Because

[21] Because ethical citizens communicate truthfully, the language is exogenously fixed and not subject to issues of babbling or inversion of messages. The Pragmatist Best Response does not uniquely define the behavior of every pragmatist type with cost above $\tilde{c}_G$ but specifies the fraction that falsely claims to vote and the complementary fraction that truthfully admits to abstention. The multiple strategies that correspond to a Pragmatist Best Response are necessarily payoff-equivalent.

the social image of an abstainer is always strictly positive, community monitoring need not be perfect to discourage lying altogether as identified by $\tilde{s} < 1$. It is straightforward to show that analogous to Property 9, if monitoring is permitted to be asymmetric across groups, *ceteris paribus*, the group with better monitoring has a higher probability of winning the election.

3.3.2 Observable Voting Costs

A different channel by which differences across communities may manifest in turnout is that in those with frequent interaction, more may be known about each individual's voting cost. Instead of being able to abstain on the grounds of a high cost of voting, a pragmatist may feel compelled to vote because others known her voting cost to be low.

Suppose that each individual believes that with probability $p \in [0, 1]$, others in her community know her cost realization, and with complementary probability, no one else knows the realization. She is thus unsure of the social image attached to her choosing to vote or abstain, and this uncertainty affects her decision to vote. For pragmatist i whose voting cost is $c_i < c^*$, the cutoff for ethical citizens in her group, she reveals that she is a pragmatist if she chooses to abstain and her voting cost is known by others. If she votes, and it is expected that a pragmatist with that cost would vote with probability 1, then her social image corresponds to the prior belief about her type; thus, voting is not socially rewarded but a failure to do is penalized. On the other hand, if it is expected that a pragmatist would not vote with that cost, but an ethical would, then her social image corresponds to that of an ethical citizen.

This race between actions and social expectations precludes the existence of a simple threshold equilibrium in which pragmatists vote at all costs below some $\hat{c} < c^*$ because the expected social image from voting would be discontinuous around $\hat{c}$. Therefore, equilibrium behavior involves pragmatists mixing between voting and abstention: suppose that a pragmatist with cost c is expected to vote with probability μ^c, and let $\hat{\mu} = \int_0^\infty \mu^c dF$ denote the participation rate from all pragmatists in this group. Let $\mu^* = F(c^*)$ denote the participation of all ethical citizens in the group. Her expected social image if she votes is:

$$\zeta\left(1,c,\mu^{c},\mu,\mu^{*}\right)=p\frac{q}{q+\left(1-q\right)\mu^{c}}+\left(1-p\right)\frac{q\mu^{*}}{q\mu^{*}+\left(1-q\right)\hat{\mu}}\qquad if a=1,c\leq c^{*}, \tag{3.7}$$

$$\left(1-p\right)\frac{q\mu^{*}}{q\mu^{*}+\left(1-q\right)\hat{\mu}}\qquad if a=1,c>c^{*}. \tag{3.8}$$

When the cost is known by others, then a citizen's image is assessed relative to the fraction of ethical citizens and pragmatists who vote at that cost in her group; when the cost remains hidden, then it is relative to the participation rate of all ethical and pragmatic citizens in her group. By reasoning similar to Property 6, there exists no equilibrium in which pragmatists vote at costs higher than that of the ethical cut-off, and so the second entry concerns an off-path event. Using this property, if a citizen abstains, her expected social image is:

$$\zeta\left(0,c,\mu,\mu^{*}\right)=\begin{cases}\left(1-p\right)\frac{q\left(1-\mu^{*}\right)}{q\left(1-\mu^{*}\right)+\left(1-q\right)\left(1-\hat{\mu}\right)} & if a=0,c\leq c^{*},\\ pq+\left(1-p\right)\frac{q\left(1-\mu^{*}\right)}{q\left(1-\mu^{*}\right)+\left(1-q\right)\left(1-\hat{\mu}\right)} & if a=0,c>c^{*}.\end{cases}$$

If a citizen abstains at costs below the ethical cutoff, the only hope for preserving some reputation is if one's voting costs weren't observed by others. In contrast, if a citizen abstains at costs above the ethical cutoff, then her behavior doesn't distinguish her from an ethical citizen conditional on the cost being observed.

If the attribution of image to actions follows that from above, then for every cost such that $\mu^c \in (0,1)$, it follows that

$$\lambda\left(\zeta\left(1,c,\mu^{c},\mu,\mu^{*}\right)-\zeta\left(0,c,\mu,\mu^{*}\right)\right)=c, \tag{3.9}$$

which uniquely defines μ^c in terms of $\hat{\mu}$. Notice that because the gap in image, $\zeta(1,c)-\zeta(0,c)$, is decreasing in $\hat{\mu}$, it follows that Equation 3.9 holds if and only if μ^c is decreasing in $\hat{\mu}$. This property guarantees uniqueness of the pragmatists' best-response.

Theorem 6. *There exists a unique political equilibrium for every* p *in* $[0, 1]$ *in which for every group* G*,*

$$c_G^*\left(q\mu_G^* + (1-q)\hat{\mu}\right) = \frac{2^{1-2\alpha}w}{B(\alpha,\alpha)}.$$

Turnout behavior is depicted in Figure 3.1 for the case in which $p = 1$, and $\lambda q < c^* < \lambda$. The solid curve in red depicts the probability with which a pragmatist at a given cost votes and the dashed curve in blue denotes the social image associated with someone voting at that cost. As noted earlier, pragmatists with low voting costs always vote generating a social image that corresponds to the prior q. At voting costs greater than λq, such a social image is not enough to convince a pragmatist to vote but it is also not an equilibrium to abstain with probability 1; pragmatists thus randomize so that the social reward matches their private cost. However, no pragmatist votes at costs that exceed the ethical cutoff, c^*.

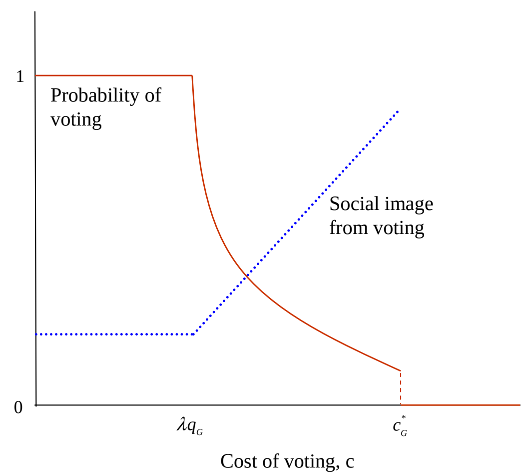

Figure 3.1: Voting behavior with observable costs

The combination of observable voting costs and social incentives can induce all pragmatists to participate exactly as much as ethical citizens (in contrast to the baseline model of Section 3.2). Consider the ethical cutoff that would be selected in a political equilibrium if all pragmatists voted just like ethical citizens: this cutoff, denoted by $c^\dagger$ uniquely solves $cF(c) = \frac{2^{1-2\alpha}w}{B(\alpha,\alpha)}$. Suppose that $p > 0$ and λ is sufficiently high that λpq is greater than $c^\dagger$. Then it trivially follows that the unique political equilibrium prescribes that all pragmatists vote in the same way as ethical citizens. Interestingly, pragmatists earn no social rewards from voting—their social image corresponds exactly to the prior q when they vote—but they are nevertheless punished by having no social esteem if they abstain at costs less than c^* and their voting cost is known by others. In communities in which others have good information about other's voting costs, extrinsic incentives have a powerful effect on turnout.

3.3.3 Endogenous Membership in Groups

We have modeled pragmatists as being affiliated with groups; the distinction between pragmatists and ethical citizens, thus far, is that pragmatists recognize that their vote makes no difference to the outcome and so are motivated to vote only to enhance their social image. An alternative notion of pragmatists is that these are independent citizens who are willing to affiliate themselves with particular groups to gain in social image from their membership but otherwise have no affinity towards any group.[22] We interpret affiliation in this extension as the choices that a citizen makes to visibly join a group or community and engage in their political and social activities prior to their decision of whether to vote. Thus, a pragmatist can join a group and then subsequently choose to abstain or vote. Communities affect turnout not only by "policing" its members as discussed in the prior extensions but also by attracting members by offering public goods and community resources as rewards for prosocial behavior. Accordingly, these results offer a different perspective on *neighborhood effects* described by Lazarsfeld, Berelson and Gaudet (1944) and others as discussed in footnote 8.

We partition the population into three groups: the fraction of pragmatists is $1-q$, and the remaining q fraction are ethical citizens of whom the fraction that is in group 1 is uniformly distributed on $[0, 1]$. The timing is as follows.

1. Each pragmatist learns her voting cost.

[22] We thank Tim Feddersen for suggesting this interpretation of pragmatists.

2. Pragmatists simultaneously choose which group to join.[23]
3. Ethicals and Pragmatists choose their voting behavior simultaneously.

Let $\rho_G : \Re \to [0,1]$ be a function such that $\rho_G(c)$ denotes the fraction of pragmatists with cost c who choose to join group G. A profile of behavior (and hence equilibrium) will correspond to affiliation functions, r_G, ethical cutoffs for each group, c^*_G, and the induced pragmatist cutoffs, $\hat{c}_G$. Given these, the perception of a citizen's moral type who joins group G and takes action a is

$$\zeta\left(a, \rho_G, \hat{c}_G, c^*_G\right) = \begin{cases} \frac{qF\left(c^*_G\right)}{qF\left(c^*_G\right)+(1-q)\int_0^{\hat{c}_G}\rho_G(c)dF} & if a = 1, \\ \frac{q(1-F\left(c^*_G\right))}{q(1-F\left(c^*_G\right))+(1-q)\int_{\hat{c}_G}^{\infty}\rho_G(c)dF} & if a = 0. \end{cases} \tag{3.10}$$

The social inferences are sophisticated insofar as the perception of a voter in group G is influenced by the fraction of pragmatists who join group G and their subsequent turnout behavior. A pragmatist's affiliation decision is influenced by these social inferences. The utility of a pragmatist that chooses to affiliate with group G and then take action a is

$$U(c, a, G) = -ca + \lambda_G \zeta\left(a, \rho_G, \hat{c}_G, c^*_G\right). \tag{3.11}$$

Our aim is to consider choices that satisfy *no regret*: a pragmatist should not be better off by changing her affiliation or subsequent voting behavior.

Definition 5. *Affiliation choice functions ρ_1 and ρ_2 constitute a **Stable Affiliation Response** to ethical citizens' and pragmatists' cutoffs $(c^*_1, c^*_2, \hat{c}_1, \hat{c}_2)$ if it satisfies the following:*

1. Feasibility*: $\rho_1(c) + \rho_2(c) = 1$.*

2. No Regret*: $\rho_G(c) > 0$ only if*

$$\begin{aligned} U(c,1,G) &\geq \max_{a\in\{0,1\},G'\in\{1,2\}} U(c,a',G') \quad \textit{for } c \leq \hat{c}_G, \\ U(c,0,G) &\geq \max_{a\in\{0,1\},G'\in\{1,2\}} U(c,a',G') \quad \textit{otherwise.} \end{aligned} \tag{3.12}$$

Feasibility is imposed merely for simplicity: it is straightforward to show that even without imposing it, pragmatists would have an incentive to join one of

[23] While it is equally realistic to suppose that affiliation happens before the realization of one's voting costs, the resulting model is messier without changing the qualitative insights.

the two groups since any unaffiliated citizen can only be a pragmatist. Stability ensures that given subsequent ethical and pragmatist voting behavior, a pragmatist does not regret her group choice. It follows that if both groups have strictly positive fraction of pragmatic voters and pragmatic abstainers, then the social esteem that accrues to voters and abstainers in both groups must be identical.

Towards understanding the thresholds for a pragmatist to vote, observe that for a pragmatist to be indifferent between voting and abstaining, her cost of voting, c, must satisfy

$$c = \max_{G \in \{1,2\}} \lambda_G \zeta\left(1, \rho_G, \hat{c}_G, c_G^*\right) - \max_{G' \in \{1,2\}} \lambda_{G'} \zeta\left(0, \rho_{G'}, \hat{c}_{G'}, c_{G'}^*\right).$$

If this condition is not satisfied, then she is strictly better off by either switching her voting decision, switching her affiliation, or both. An immediate consequence of Stability is that if the threshold type $\hat{c}_G$ is being split across both groups ($\rho_G(\hat{c}_G) \in (0,1)$), then $\hat{c}_1 = \hat{c}_2$. In contrast, if this threshold type is joining only one of the groups (e.g. group 1) then stability does not automatically impose equality but it violates stability for a pragmatist in group 2 to be voting with a cost $c > \hat{c}_1$, and to be abstaining at a cost $c < \hat{c}_1$. Therefore, it is without loss of generality to impose $\hat{c}_1 = \hat{c}_2$. We restrict the notion of Definition 5 accordingly.

Definition 6. *A profile of Pragmatic Behavior,* $(\rho_1, \rho_2, \hat{c})$*, is a* Stable Response *to ethical citizens' cutoffs* (c_1^*, c_2^*) *if it satisfies the following:*

1. (ρ_1, ρ_2) *is a Stable Affiliation Response to* $(c_1^*, c_2^*, \hat{c}, \hat{c})$*.*
2. $\hat{c}$ *solves*

$$c = \max_{G \in \{1,2\}} \lambda_G \zeta\left(1, \rho_G, c, c_G^*\right) - \max_{G' \in \{1,2\}} \lambda_{G'} \zeta\left(0, \rho_{G'}, c, c_{G'}^*\right). \tag{3.13}$$

To account for endogenous affiliation in equilibrium, we need to extend the Consistent Ethical Response to account for affiliation choices; this is straightforward and hence relegated to the Supplementary Appendix. Using these concepts, we define the equilibrium concept in this section.

Definition 7. *A* ***Free Entry Political Equilibrium*** *(FEPE) is a profile* $\left\{ (\rho_1, \rho_2, \hat{c}), (c_1^*, c_2^*) \right\}$ *such that:*

1. (c_1^*, c_2^*) *is a Consistent Ethical Response to* $(\rho_1, \rho_2, \hat{c})$*,*

2. $(\rho_1, \rho_2, \hat{c})$ *is a Stable Response to* (c_1^*, c_2^*)*.*

We prove existence and (essential) uniqueness of this equilibrium.

Theorem 7. *The set of FEPE is non-empty and is* essentially unique*: all FEPE are payoff equivalent, have the same ethical and pragmatist cutoffs, and the same probability of victory for group* 1*.*

The source of multiplicity of FEPE is the indifference that pragmatists have for joining either party (in equilibrium): there may be infinitely many variations of (ρ_1, ρ_2) that are consistent with an FEPE without changing the mass of pragmatists who join either group, the cost thresholds for voting, or the probability of victory.

Establishing Theorem 7 involves several steps and is involved. The first step is to recognize that voting behavior is driven by not the affiliation choices of a particular cost type, but by the aggregate mass of pragmatists who join either group. Thus, any FEPE can be translated to one with identical aggregate voting behavior but *simple affiliation choices* in which pragmatists randomize between which groups to join in a manner that is virtually cost independent: for every cost $c \leq \hat{c}$, $\rho_1(c) = \underline{r}$ and for every cost $c > \hat{c}$, $\rho_1(c) = \bar{r}$ for some $\underline{r}$ and $\bar{r}$ in $[0, 1]$. Thus, it suffices to establish existence and uniqueness within this simpler class of FEPE.

The second step is to note that for every pair of ethical cutoffs (c_1^*, c_2^*), there exists a unique simple stable response for pragmatists. Once this uniqueness is established, the first order conditions for the Consistent Ethical Response can be analyzed as in Section 3.2 and shown to have a unique solution when k is distributed uniformly.

Recall as identified in Properties 8 and 9 that if ethical citizens in group 2 value the election more their counterparts in Group 1 (i.e. $w_2 > w_1$), or there are stronger social incentives in group 2 ($\lambda_2 > \lambda_1$), then pragmatists in group 2 have a higher cutoff for voting ($\hat{c}_2 > \hat{c}_1$). This distinction disappears with endogenous membership since an FEPE involves $\hat{c}_2 = \hat{c}_1$; with endogenous membership, asymmetries do not manifest in the cutoffs for voting, but in the fraction of pragmatists that are attracted to a particular group. As we show below, the group that considers the election more important or has stronger social incentives in equilibrium is larger, and therefore, wins the election with greater probability.

Property 10. *When the election is more important to group 2 than to group 1, the participation rates of ethical citizens in group 2 is higher than in group 1. More pragmatic voters affiliate with group 2 and group 2 has a higher probability of winning the election.*

The greater importance of the election prompts the stronger group's ethical citizens to increase their participation rate. This asymmetric ethical participation rate then affects the incentives for pragmatist voters to join the stronger group. Group 2, with a higher ethical participation rate, and higher affiliation among pragmatist voters wins with a higher probability. We now consider the role of asymmetric social incentives.

Property 11. *When group 2 has stronger social incentives than group 1, ethical citizens in group 2 participate less than in group 1. Nevertheless, a larger fraction of pragmatic voters are attracted to group 2, and so group 2 has a higher probability of victory.*

The force that drives this property is that for a pragmatist voter in group 1 to not have an incentive to switch to group 2, there must be a larger fraction of pragmatist voters in group 2 that sullies the social image of being a voter in that group.

3.3.4 Other Extensions

We describe two other extensions whose formal details, for the sake of brevity, are relegated to the Supplementary Appendix.

Naïve Ethics: Ethical decisionmaking in our model embeds a sophisticated understanding of the heterogeneity of motives of citizens across and within groups. Although it resonates with equilibrium analysis, this form of consistency may be more sophisticated than ethical heuristics used in practice. We propose a tractable variant of naïve ethics in which each ethical citizen believes that every citizen is ethical. We show that a naïve analogue to political equilibrium exists and is unique.

In comparison to our benchmark setting, the naïve political equilibrium features lower turnout but has similar comparative statics.

Continuum of Types: A simplification of our basic framework is its bifurcation of the population into ethical citizens and pragmatists; we describe an extension in which individuals value following an ethical rule to different degrees, as captured by an *ethical coefficient*. Generalizing the binary setting reveals a subtle aspect of the definition of ethical rules: there must be some group of "pure ethical citizens" whose behavior, holding fixed the behavior of all others, follows the ethical rule. Otherwise, a Consistent Ethical Response fails to exist. Accordingly, we define pure ethical citizens to be those who have a strict incentive to follow the ethical rule, and other citizens care about the extent to which they are seen to be a pure ethical. A unique political equilibrium continues to exist in this setting.

3.4 An Application to Electoral Competition

This section discusses the implications that our framework for turnout has on how political candidates choose platforms in a competitive election. We show that office-motivated candidates converge to a single platform so that there is no turnout in equilibrium whereas policy-motivated candidates diverge generating a non-trivial turnout in equilibrium. In both cases, candidates pander towards the group that is more mobilized to vote, i.e. the one that is most responsive to policy, or has stronger social incentives.

We illustrate these issues using the simplest possible example: each of the two candidates commit to a platform p from a policy space, P_x, with three possible locations, $\left\{\frac{3}{2}- \ x, \frac{3}{2}, \frac{3}{2}+ \ x\right\}$, in which $x \in (0, 1/2)$. The payoff of group G from the selected policy being p is $\kappa_G u\left(|p-G|\right)$ in which $\kappa_G > 0$ is the responsiveness of group G to policy, and the function u is smooth, strictly decreasing, and strictly concave. When candidates 1 and 2 choose platforms p_1 and p_2 respectively, the difference between the two endogenizes the importance of the election:

$$w_G(p_1, p_2) = \kappa_G \big| u\left(|p_1 - G|\right) - u\left(|p_2 - G|\right) \big|.$$

When the two candidates choose the same platform, then no citizen votes ensuring that each candidate wins with equal probability. To guarantee existence and uniqueness of a Consistent Ethical Response, we assume that the fraction of citizens in group 1 is uniformly distributed on $[0,1]$. The groups are entirely symmetric except that group 2 may be more responsive to policy ($\kappa_2 > \kappa_1$) or have stronger social incentives ($\lambda_2 > \lambda_1$). For expositional clarity, we separate the two forms of asymmetries; as a normalization, we set $\kappa_1 = 1$ and write κ for κ_2.

We begin by studying candidates who are motivated purely by office. In any equilibrium, each candidate must have an equal probability of winning since otherwise, a candidate can deviate to the other's position to ensure no turnout and split the election. Accordingly, candidate incentives are assessed by examining when a platform in P_x defeats another platform with probability greater than $\frac{1}{2}$. When one candidate chooses platform $\frac{3}{2}$ and the other selects $\frac{3}{2}+x$, the ratio of the importance of the election to groups 1 and 2 is

$$\frac{w_1(p_1,p_2)}{w_2(p_1,p_2)} = \left(\frac{1}{\kappa}\right)\left(\frac{u\left(\frac{1}{2}\right) - u\left(\frac{1}{2}+x\right)}{u\left(\frac{1}{2}-x\right) - u\left(\frac{1}{2}\right)}\right).$$

Because u is strictly concave, the second term on the RHS (henceforth denoted by κ_x) exceeds 1: distinct platforms biased towards group 2's preferred policy would induce greater turnout from members of group 1 if the groups are equally responsive. Accordingly, a sufficiently large gap in responsiveness or social incentives is needed for platforms to pander to group 2.

Theorem 8. *In the unique equilibrium, office-motivated candidates select the same platform, which is either $\frac{3}{2}$ or $\frac{3}{2}+x$.*

1. Asymmetric Responsiveness*: The equilibrium platforms satisfy*

$$p_1 = p_2 = \begin{cases} \frac{3}{2} & \text{if } \kappa < \kappa_x, \\ \frac{3}{2}+x & \text{if } \kappa > \kappa_x. \end{cases}$$

2. Asymmetric Social Incentives*: There exists $\overline{\kappa} > 1$ and $\underline{\lambda}$ such that if $\kappa_x < \overline{\kappa}$ and $\lambda_2 > \underline{\lambda}$, then the unique platform is $\frac{3}{2}+x$.*

All citizens abstain on the equilibrium path and each candidate wins with equal probability.

When citizens balance the costs of voting with its benefit, electoral platforms are affected by the intensity of citizens' preferences—as captured by responsiveness—and not simply their orderings. Even though no citizen turns out in equilibrium, platforms pander towards groups that have a greater incentive to vote for otherwise one candidate could do better by unilaterally pandering. The extent to which candidates pander is balanced by κ_x; yet, if the policy space were continuous, our results indicate that any asymmetry in responsiveness or social incentives will induce at least some pandering (since $\kappa_x \to 1$ as $x \to 0$). Finally, since each candidate's probability of victory is $\frac{1}{2}$, office-motivated candidates have no incentive to devote resources to social incentives.

In contrast, policy-motivated candidates choose divergent platforms sacrificing winning probability for a more preferable policy should they win.[24] Suppose that candidate G has a preferred policy of G and her payoff from policy p being implemented is $v\left(|p-G|\right)$, where v is smooth, strictly decreasing, and strictly concave. Since the candidates do not choose the same platform in equilibrium, their divergent profiles induce turnout in equilibrium. The asymmetries between the groups shapes electoral competition, and therefore influence whether equilibrium platforms are $\left(\frac{3}{2}-x, \frac{3}{2}+x\right)$ or $\left(\frac{3}{2}, \frac{3}{2}+x\right)$; also playing a critical role is the extent to which candidate 1 is willing to select the centrist position. Let

$$v_x = \frac{v\left(\frac{1}{2}-x\right) - v\left(\frac{1}{2}+x\right)}{v\left(\frac{1}{2}\right) - v\left(\frac{1}{2}+x\right)} > 1.$$

Theorem 9. *Policy-motivated candidates select different platforms in the unique equilibrium. The equilibrium platforms are either* $\left(\frac{3}{2}-x, \frac{3}{2}+x\right)$ *or* $\left(\frac{3}{2}, \frac{3}{2}+x\right)$*; the latter is the unique equilibrium if responsiveness or social incentives are sufficiently asymmetric as described below:*

1. Asymmetric Responsiveness*: There exists* $\overline{v} > 1$ *and* $\overline{\kappa}$ *such that if* $\kappa > \overline{\kappa}$ *and* $v_x < \overline{v}$*.*

2. Asymmetric Social Incentives*: There exists* $\overline{v} > 1$*,* $\overline{\kappa} > 1$*, and* $\underline{\lambda}$ *such that if* $v_x < \overline{v}$*,* $\kappa_x < \overline{\kappa}$*, and* $\lambda_2 > \underline{\lambda}$*.*

[24] This divergence echoes results from Wittman (1983) and Calvert (1985) who show that policy-motivated candidates diverge when voting is costless and candidates are uncertain about the distribution of voter preferences.

Citizens vote on the equilibrium path, and the probability with which candidate 2 *wins is increasing in the relative responsiveness* (κ) *or social incentives* (λ_2) *in group* 2*.*

A policy-motivated candidate 1's only incentive to pander to group 2 is that it increases his probability of victory at the expense of the policy should he win: by biasing platforms towards group 2, the election becomes relatively less important to group 2 than to members of group 1, and so candidate 1 can improve his winning odds by pandering towards group 2 despite knowing that no citizen in that group votes for him. Moreover, unlike an office-motivated candidate, a policy-motivated candidate has an incentive to augment the social incentives in the group that favors him since this improves the probability with which a policy closer to his ideal point is selected.

The above results illustrate in this stylized setting as to how candidates have an incentive to pander towards groups that are more mobilized to vote. This pandering motive highlights why political elites wish to expend effort towards social incentives, as studied in group mobilization models (e.g. Uhlaner, 1989; Morton, 1991; Shachar and Nalebuff, 1999): mobilization efforts influence not only the probability with which one's favored candidate wins, but also the platforms of each candidate.

3.5 Conclusion

This paper offers a simple model for turnout that integrates ethical and signaling motives, generates predictions for turnout that are consistent with existing evidence, and may be useful to understand the links between voter mobilization and community monitoring as well as electoral competition. We conclude by briefly noting two important directions in which the current work may be extended.

We anchor social incentives and esteem to the rule-utilitarian notion of duty and ethics formulated by Coate and Conlin (2004) and Feddersen and Sandroni (2006*a*,*c*). Apart from its intrinsic appeal, the ethical voter framework has proven useful in a number of contexts and thus presents a natural starting point for our analysis. Alternative notions of ethics may involve the ethical type experiencing a constant warm-glow from voting or being a strategic agent with altruistic preferences. The weakness of the first approach is that by divorcing the content of duty from the fundamentals of the election, it fails to capture the competitive nature of turnout, and the resulting impact that this has on electoral competition. The latter vein, as studied by Edlin, Gelman and Kaplan (2007) and Evren (2010), behaves similarly to the ethical voter framework but with an attractive feature of relying on standard equilibrium concepts; it would be interesting to understand the extent to which insights similar to those here may be derived in that setting.

Our framework treats social incentives as being shaped but exogenous to the political process; in reality, they are shaped by the choices of political elites and leaders who, as Grossman and Helpman (2002) and Shachar and Nalebuff (1999) suggest, exert costly effort towards monitoring and motivating "followers" to vote. We consider it an important direction for future work to endogenize the strength of social incentives, and integrate the incentives of leaders with those of followers to appear ethical.

Chapter 3, in full, is a reprint of the material as it appears in the American Economic Journal: Microeconomics, 2013. Ali, S. Nageeb, and Charles Lin "Why People Vote: Ethical Motives and Social Incentives", *American Economic Journal: Microeconomics*, 314, 5(2):73-98, 2013.

Appendix A

Proofs for Chapter 1

A.0.1 Proofs for Section 1.3

Proof of Proposition 1. We show that strategies that delay do not survive iterated deletion of dominated strategies. Suppose i receives a signal arrival at time t, and $m\Delta$ is the closest node after t. Consider a strategy where i reports at $n\Delta > m\Delta$. i's strategy is dominated unless j's strategy reports with zero probability in $[m\Delta, n\Delta]$.

If i's strategy is to wait until $n\Delta$, then for j, waiting past $n\Delta$ conditional on an arrival in $(m\Delta, n\Delta)$ is dominated by any strategy that reports before $n\Delta$. Delay for i is not dominated only if j delays, but j's delay is dominated.

Finally, consider the strategy profile where both players wait indefinitely. Each player has an incentive to deviate, and thus this profile does not survive iterated deletion. □

Let $V_i(\mu)$ be player i's continuation value given belief μ. The stochastic Bellman equation is

$$V_i(\mu(t)) = \max\{\mathbb{E}_{\alpha_j} R_i(\mu, m_j), e(\mu)\mathbb{E}U(m_i^*|e) + (1 - e(\mu))V_i(\mu(t + \Delta))\}$$

where $e(\mu)$ is the probability of evidence arrival for either player., and let e represent the event that evidence arrives for either player. Notice that $\lim_{\Delta\to 0} e(\mu) = 0$, so its precise value is not important.

Proof of Lemma 1. First, note that $\lim_{t\to\infty} \mu(t) = 0$ and $\lim_{t\to\infty} R_i(\mu(t), \emptyset) = 1 + \beta(L, L)$.

$$\begin{aligned}\lim_{t\to\infty} R_i(\mu(t), \emptyset) + R_j(\mu(t), \emptyset) &= 2 + 2\beta(L, L)\\ &> 2 + \beta(L, L)\\ &> \lim_{t\to\infty} V_i(\mu(t)) + V_j(\mu(t))\end{aligned}$$

As $t \to \infty$ at least one player has a strict incentive to act, regardless of his opponent's strategy at t. □

Proof of Lemma 2. This proof proceeds by induction with Lemma 1 as the base step. For the inductive step, suppose there exists some $\hat{t} > \bar{t}$ where $\sigma_i(Q_t) = L$, but at $\hat{t} - \Delta$ $\sigma_1(Q_t) = \sigma_2(Q_t) = L$. In the period before $\hat{t}$ as $\Delta \to 0$,

$$\lim_{\Delta\to 0} V_i(\mu(\hat{t} - \Delta)) = \max\{R_i(\mu, \emptyset), V_i(\mu(\hat{t}))\}$$

$V_i(\mu(\hat{t})) + V_j(\mu(\hat{t})) \leq 2 - \mu(\hat{t}) + \beta$, but $\lim_{\Delta\to 0} R_i(\mu(\hat{t}-\Delta), \emptyset) + R_j(\mu(\hat{t}-\Delta), \emptyset) = 2 - 2\mu(\hat{t}) + 2\beta > 2 - \mu(\hat{t}) + \beta > \lim_{\Delta\to 0} V_i + V_j$, so if $R_i < V_i$, then $R_j > V_j$, and vice versa. □

Proof of Lemma 3. Again, we argue by induction. First, we show that both players prefer N at the first period before $\bar{t}$. Then, we show that for $t \in (\underline{t}, \bar{t})$, if a player prefers to wait in the next period, then that player prefers to wait in the current period.

Base Step. Examine $\bar{t} - \Delta$, and assume that i preempts at $\bar{t}$, while j remains quiet.

$$V_i(\mu(\bar{t}-\Delta)) = \max\{\mathbb{E}_{\alpha_j} R_i(\mu, m_j), e(\mu)\mathbb{E}U(m_i^*|e) + (1-e(\mu))V_i(\mu(t))\}$$

By definition, $R(\mu(\bar{t}-\Delta), \emptyset) < 1$, while $V_i(\mu(\bar{t})) = R(0, \mu(\bar{t})) = 1 - \mu(\bar{t}) + \beta > 1$. As $\Delta \to 0$, both $e(\mu)$ go to zero. So for sufficiently small Δ, the second term in the max expression is larger than the first, and 1 strictly prefers to wait at $\bar{t} - \Delta$.

Inductive Step. Now examine j's incentive to act at $\bar{t} - \Delta$. As j is preempted at $\bar{t}$, $V_j(\mu(\bar{t})) = 1$ $R(\bar{t}, \emptyset) < 1$. Arrivals for either player yield payoffs of at least 1, so j's second term in the max expression is greater than the first.

Now that we've established that both players prefer $\emptyset$ at $t_2 - \Delta$, we examine the inductive step. Suppose for some $\hat{t}$ where $\mu(\hat{t}) \in (\beta, \frac{1}{2})$, both players have $a_i(Q_t) = \emptyset$ for all $t \in (\hat{t}, \bar{t})$.

Because both players preferred $m = \emptyset$ at $\hat{t} + \Delta$, $V_i(\mu(\hat{t}+\Delta)) \geq R_i(\mu(\hat{t}+\Delta), \emptyset) > R_i(\mu(\hat{t}), \emptyset)$. $R_i(\mu(\hat{t}), \emptyset)$ is smaller than any potential payoff from waiting, so both players prefer to wait at $\hat{t}$. □

Proof of Lemma 4. Suppose $\sigma_i(Q_t) = H$ for some $\hat{t}$ such that $\mu(\hat{t}) > \frac{1}{2}\beta$. Examine when i is the only player to choose H at $\hat{t}$. Examine j's incentive to report at $\hat{t} - \Delta$

For j, $V_j(\hat{t}) = 1$. As $\Delta \to 0$, $e(\mu(t) \to 0$. For Δ close to zero, the second term of the max expression goes to $V_j(\hat{t}) = 1$, while the first term is bounded above $R(\mu(\hat{t}), \emptyset)$, which by definition is greater than 1, so j has an incentive to report at $\hat{t} - \Delta$.

Lastly, if both players choose H at $\hat{t}$, $V_i(\mu(\hat{t}-\Delta)) + V_j(\mu(\hat{t}-\Delta)) < 2\mu(\hat{t}-\Delta) + \beta(L, L)$, so the result still holds. □

Property 12. *For any $\epsilon > 0$, $\exists\bar{\Delta}$ such that $\forall t \in [0, \bar{t}]$ and $\forall \Delta < \bar{\Delta}$, $|W_i(t) - \tilde{V}_i(\mu)| < \epsilon$.*

The next property shows that $W_i(t)$ uniformly converges to the true value of waiting until the node after $\bar{t}$.

Let the node after $\bar{t}$ be $\bar{t}'$. Let $\tilde{V}_i(\mu)$ be the utility of waiting until $\bar{t}'$.

Proof of Property 12. Note that as $\Delta \to 0$, $\bar{t}' \to \bar{t}$. Thus the duration of wait approaches that of W_i for $\tilde{V}_i$ as $\Delta \to 0$.

The probability of a joint arrival of evidence for both players goes to zero as $\Delta \to 0$. $\tilde{V}_i(t)$ is continuous in both $\bar{t}'$ and the probability of joint evidence arrival, so as $\Delta \to 0$, $\tilde{V}_i(t) \to W_i(t)$. □

Proof of Theorem 1. The proof is divided into two sections, one for late report equilibria, and the other for early reports.

Late Report Equilibria. From Lemma 1 through Lemma 2, we have that there exists $\bar{\Delta}$ such that for all $\Delta < \bar{\Delta}$, $\sigma_1(Q_t) = L$ or $\sigma_2(Q_t) = L$ for all $t > \bar{t}$.

Lemma 3 shows that both players strictly prefer $\emptyset$ for $t \in (\check{t}, \bar{t})$. For $t < \check{t}$, Lemma 4 shows if any player chooses H, at least one player chooses H at each t before. If at each t, $R_i(\mu(t), \emptyset) < W_i(t)$, $\sigma_1(Q_t) = \sigma_2(Q_t) = N$ for $t < \bar{t}$.

Early Report Equilibria. From Lemma 1 and Lemma 2, we have that $\exists\Delta$ close to zero such that, $\sigma_1(Q_t) = L$ or $\sigma_2(Q_t) = L$ for $t > \bar{t}$. Lemma 3 shows that both players prefer $\emptyset$ for $t \in (\check{t}, \bar{t})$. However, if for some t, $R_i(\mu(t), \emptyset) > W_i(t)$ then player i would prefer to act at t rather than wait until $\bar{t}$. For Δ close to zero, $R_i(\sigma_j, \emptyset) > W_i(\bar{t} + \delta)$, and i prefers to act at t rather than wait until $\bar{t}$. From Lemma 4, we know that if $\sigma_i(Q_t) = H$ at some $t < \check{t}$, then $\sigma_i(Q_t) = H$ for at least one player for all t before, so $\sigma_i(Q_t) = H$ for at least one player. Finally, if $R(\mu_0, m_j)|_{m_j \neq \emptyset} < 1$ then it is not an equilibrium for both players to report at zero, so only one player can report, a single early report equilibrium. If $R(\mu_0, m_j)|_{m_j \neq \emptyset} > 1$, then both players prefer to split the prize at time zero, causing a double early report equilibrium. □

A.0.2 Mixed Strategy Equilibria

In this part we provide sufficient conditions for the existence of mixed strategy PBE that are not payoff equivalent to pure strategy PBE. We find that if nonpayoff equivalent mixed strategy PBE exist, they are the only nonpayoff equivalent ones. We characterize the set of mixed strategy equilibria and compare them to the pure strategy equilibria.

Theorem 10. *There exists at most one mixed strategy PBE that is payoff nonequivalent to the pure strategy PBE.*

The structure of the particular mixed strategy equilibrium of Theorem 10 mirrors that of late report equilibria, except in $(\bar{t}, \bar{\bar{t}})$, instead of alternating pure actions, both Senders mix with increasing probability of report. Senders fully mix with a unique density in this region, and probability of report only reaching 1 at $\bar{\bar{t}}$.

Because there is a positive probability that play reaches past $\bar{t}$ in this mixed strategy equilibrium, the ex ante expected utilities of both players are higher. Less surplus is destroyed as both Senders have longer to accumulate evidence before reporting, and the continuation values of both players at $\bar{t}$ are higher than in the pure strategy equilibrium case.

Because the expected utility of waiting until $\bar{t}$ for a mixed strategy equilibrium is higher than for the pure strategy case, there exist parameters where all pure strategy PBE are early report equilibria, while at the same time there exists mixed strategy equilibrium with strictly positive probability of reaching past $\bar{t}$.

It is possible that pure strategy equilibria have early, $t = 0$ reports, while mixed strategy equilibria do not. This is because the continuation values for the mixed strategy equilibrium are strictly higher than those of the pure strategy case. Thus it is possible for certain parameter values that the pure strategy equilibrium has early reporting, while the mixed strategy equilibrium only begins to report at $\bar{t}_2$.

Finally, we discuss payoff equivalent mixed strategy equilibria. At $\bar{t}$ conditional on a quiet history, all mixed strategy equilibria that are payoff equivalent to pure strategy PBE have the first report at $\bar{t}$, followed by a period of single Sender reporting. If mixing begins at some time $\tilde{t} \in (\bar{t}, \bar{\bar{t}})$, then both players fully mix at all $t \in (\tilde{t}, \bar{\bar{t}})$.

Although beliefs about the state are public at each decision node, players derive different utility for waiting until the next Δ because of the asymmetric evidence arrival rate. Sender 2 has the more informative signal, so waiting yields higher utility than for 1, and so 1 must mix with lower probability than 2 to keep him indifferent between acting and waiting.

Fixing parameters, there exists at most one mixed strategy PBE that is not payoff equivalent to pure strategy PBE, and it attains higher ex ante payoffs than all other equilibria. We provide sufficient conditions for its existence, but there exist a multiplicity of mixed strategy PBE with payoffs identical to pure strategy PBE.

Mixed Strategy Equilibria

We proceed by backward induction, and Lemma 1 initially gives us that taking an action for $t > \bar{\bar{t}}$ is a dominant strategy for both players. Borrowing the intuition from Lemma 8, the next lemma states that in $(\bar{t}, \bar{\bar{t}})$, if a player is acting with probability one at some t, then at least one player acts for all periods before t.

Lemma 8. *There exists* $\bar{\Delta} > 0$ *such that for all* $\Delta < \bar{\Delta}$ *and* $t \in (\bar{t}, \bar{\bar{t}})$, *if* $\alpha_{i,t+\Delta}(L) = 1$ *and* $\alpha_{j,t+\Delta}(L) = 0$ *then* $\alpha_{i,t}(L) = 0$ *and* $\alpha_{j,t}(L) = 1$.

Proof of Lemma 8. If $\alpha_{i,t}(L) = 1$ and $\alpha_{j,t}(L) = 0$, then

$$\begin{aligned} V_i(\mu(t)) &= 1 - \mu + \beta(L, L) \\ V_j(\mu(t)) &= 1 \end{aligned}$$

$R(\mu(t), \emptyset) = 1 - \mu(t-\Delta) + \beta(L,L) < 1 - \mu(t) + \beta(L,L)$, and $R(1, \mu(t)) = 1 - \mu(t-\Delta) + \frac{1}{2}\beta(L,L) < 1$, as $\Delta \to 0$,$e(\mu) \to 0$, so i strictly prefers to wait. For j, $R(0,t) = 1 - \mu(t-\Delta) + \beta > 1$, but $V_j(t) = 1$. But again, as $\Delta \to 0$, $e(\mu) \to 0$,so for Δ close to zero j strictly prefers to act. □

While the intuition of Lemma 8 is used to find the structure of pure strategy equilibria in $\Delta < \bar{\Delta}$, it can also be used to determine the structure of mixed strategy equilibria that are not payoff equivalent. If a mixed strategy equilibrium has a different continuation value at the beginning of Region II than the pure strategy equilibria, then it cannot be taking a pure action in the first period of Region II. By Lemma 8, neither player can take a pure action in Region II, and must be mixing. Lemma 9 states that this mixture probability is unique.

Lemma 9. *If* $\alpha_{i,t} = \tilde{\alpha} \in (0,1)$ *for an equilibrium, then for all equilibria, if* $\alpha_{i,t} \in (0,1)$*, then* $\alpha_{i,t} = \tilde{\alpha}$*.*

Proof of Lemma 9. For i to be indifferent to mix, $\alpha_{j,t}$ must satisfy the following equation.

$$(1-\alpha_{j,t}(L))R(0,\mu) + \alpha_{j,t}(L)R(1,\mu) = (1-\alpha_{j,t}(L))\Big[(\mu e^{-\lambda_H \Delta} + (1-\mu)e^{-\lambda_L})V_i(\mu(t+\Delta)) + e(\mu)\mathbb{E}U(m^*|e)\Big] + \alpha_{j,t}(L)$$

Because $\alpha_{j,t}$ enters linearly in the above equation, if it is satisfied, it must be unique given $V_i(\mu(t))$.

Given $\alpha_{i,t}(L) \in (0,1)$, then by the Lemma 8 we know that $\forall \hat{t} > t$, $\alpha_{i,\hat{t}}(L) \in (0,1)$. Inducting backwards from $\bar{t}_2$, which has a continuation value common to all equilibria, the period before $\bar{t}$ has a unique positive mixture probability. This induces a unique continuation value for that period, which implies a unique positive mixture probability for the previous period. □

Proof of Theorem 10. From the proof of Lemma 8, if an equilibrium has pure actions in $(\bar{t}, \bar{\bar{t}})$, it is payoff equivalent to a pure strategy equilibrium. If a mixed strategy equilibrium has a payoff that differs from the pure strategy equilibrium, then it must have full mixing in Region II. From Lemma 9, each mixture probability is uniquely determined by the continuation value of the next period. All equilibria must have both Senders reporting in Region I, there is only one equilibrium with full mixing in Region II. □

Property 13. *For any mixed strategy equilibria, if* $\alpha_{1,t}, \alpha_{2,t} \in (0,1)$ *for* $t \in (\bar{t}, \bar{\bar{t}})$*, then* $\alpha_{1,t}(L) > \alpha_{2,t}(L)$*.*

Proof of Property 13. For i to be indifferent,

$$(1-\alpha_{j,t}(L))R(0,\mu) + \alpha_{j,t}(L)R(1,\mu) = (1-\alpha_{j,t}(L))\Big[(\mu e^{-\lambda_H \Delta} + (1-\mu)e^{-\lambda_L})V_i(\mu(t+\Delta)) + e(\mu)\mathbb{E}U(m^*|e)\Big] + \alpha_{j,t}(L)$$

If $\lambda_{2,\theta} > \lambda_{1,\theta}$, then $e(\mu)\mathbb{E}U_2(m^*|e) > e(\mu)\mathbb{E}U_1(m^*|e)$. For 1, the value in the square brackets is lower than that of 2's. Thus 2 must mix and choose L with lower probability to make 1 indifferent between reporting and waiting. □

Proofs for Section 1.4

Proof of Proposition 2. First, given that the Receiver will choose the action with higher probability of matching the state,

$$\mathbb{E}U_I(a_D, t_D) = \begin{cases} e^{-rt_D}\mu(t_D) & \text{if } \mu \geq \frac{1}{2} \\ e^{-rt_D}(1-\mu(t_D)) & \text{if } \mu < \frac{1}{2} \end{cases}$$

Examine the first order conditions for the Direct Observer's utility.

$$\frac{d\mathbb{E}U(a_D, t_D)}{dt_D} = -re^{-rt_D}\mathbb{1}|_{a_D=\theta} + e^{-rt_D}\frac{d\mathbb{1}|_{a_D=\theta}}{dt_D} \tag{A.1}$$

If $t < \check{t}$,

$$\frac{d\mathbb{E}U(a_D, t_D)}{dt_D} = -re^{-rt_D}\mu(t_D) + e^{-rt_D}\frac{d\mu(t_D)}{dt_D} \qquad < 0$$

For $t > \check{t}$,

$$\frac{d\mathbb{E}U(a_D, t_D)}{dt_D} = -re^{-rt_D}(1-\mu(t_D)) - e^{-rt_D}\frac{d\mu(t_D)}{dt_D} \tag{A.2}$$

As $t \to \infty$, $\mu \to 0$ and $\mu'(t) \to 0$, so for r sufficiently close to zero, there exists $t_I^* > \check{t}$ such that $\frac{dU(a_D^*, \bar{t}_D^*)}{dt} = 0$. So, either $\bar{t}_D = t_D^*$ or $\bar{t}_D = 0$. □

Proof of Proposition 3. If the Bayesian and Direct Observer have identical ex ante expected utility, then the Bayesian receives a signal that is equivalent to the Direct Observer, who stops at $\bar{t}_D$. This can only occur in late equilibria where $\bar{t} > \bar{t}_D$, so Senders do not report without evidence before an Direct Observer would have acted without information. □

Proof of Proposition 4. In double early report equilibria, the Bayesian receives no signal from two Senders, but receives a single signal with the monopolist, and thus prefers the monopolist. In single early report equilibria, the Bayesian receives a single signal in both cases and is thus indifferent. In late report equilibria, if $\bar{t}_D < \bar{t}$, the Bayesian acts before the Senders report without evidence. With two Senders, the Receiver reaches his cutoff belief faster than with a single Sender. □

Proof of Proposition 5. The reasoning is identical to that of Proposition 3. □

Proof of Proposition 6. In early report equilibria, the Credulous Receiver acts at $t = 0$, and would therefore prefer a monopolist, who does not report at time zero. For late report equilibria, if $\bar{t}_D \leq \bar{t}$, the Credulous Receiver acts without a report before the Sender reports without evidence. In this case, the Receiver strictly prefers duopoly, because of the faster learning rate, without the early reporting. □

Proof of Proposition 7. In late report equilibria, waiting periods merely impose a evidence delay costs, while conferring no benefits to either Receiver. In double early report equilibria, both Bayesian and Credulous Receivers get no information from reports if $\tau = 0$. If $\tau > 0$, there is a strictly positive probability that L evidence will arrive, in which case Senders report L at τ, and Receivers act at τ. In single early reports, Credulous Receivers act immediately with no information. Waiting periods allow the possibility of L arrival during the waiting period. □

Appendix B

Proofs for Chapter 2

Proof of Proposition 11. It is sufficient to show that a singleton menu can profitably persuade the Receiver. For anyα, choose $\hat{t}$ such that $U(\alpha, \hat{t}(\alpha), \hat{\mu})$. For $t \leq \hat{t}$, I examine the loIst Receiver type that would purchase the signal, $\underline{\mu} = \frac{-t}{\alpha u_L}$, and the highest Receiver type that would purchase the signal, $\bar{\mu} = \frac{u_H - t}{u_H - (1-\alpha) u_L}$.

We can rewrite the Sender's profit function as

$$\Pi(\alpha, t) = \pi F(\underline{\mu}) + \pi(F(\bar{\mu}) - F(\underline{\mu}))[(1-\mu_0) + \mu_0(1-\alpha)) + t].$$

I will define a profit function excluding the transfers,

$$\begin{aligned} \tilde{\Pi}(\alpha, t) &= \pi F(\underline{\mu}) + \pi(F(\bar{\mu}) - F(\underline{\mu}))[(1-\mu_0) + \mu_0(1-\alpha))] \\ &\leq \Pi(\alpha, t) \end{aligned}$$

Taking the derivative of this modified profit function with respect to the transfer t,

$$\frac{d\tilde{\Pi}}{dt} = -\pi f(\underline{\mu}) \frac{d\underline{\mu}}{dt} + \pi(f(\bar{\mu}) \frac{d\bar{\mu}}{dt} - f(\underline{\mu}) \frac{d\underline{\mu}}{dt})[(1-\mu_0) + \mu_0(1-\alpha))].$$

Notice that when $\alpha = 0$,

$$\begin{aligned} \frac{d\tilde{\Pi}}{dt}|_{\alpha=0} &= \pi f(\bar{\mu}) \frac{d\bar{\mu}}{dt} \\ &= -\pi f(\bar{\mu}) \frac{1}{u_H - u_L} \\ &< 0 \end{aligned}$$

By continuity of Π in α, for α close to zero, $\frac{d\tilde{\Pi}}{dt} < 0$. Offering a signal at α and $\hat{t}(\alpha)$ yields the same profit as no menu at all, but marginal decreases to t for low α are profitable for the Sender. As t decreases, a neighborhood of types around $\hat{\mu}$ purchases a signal. □

Proof of Theorem 2. From Proposition 11, the threshold Receiver receives a signal with $\alpha > 0$.

Thus the Sender does not fully disclose the state for free.

$$\begin{aligned} \Pi(\alpha, t) &= \pi[F(\underline{\mu}) + (F(\bar{\mu}) - F(\underline{\mu}))[(1-\mu_0) + \mu_0(1-\alpha))]] + [F(\bar{\mu}) - F(\underline{\mu})]t \\ \frac{d\Pi(\alpha, t)}{dt}|_{\alpha=1, t=0} &= \pi[f(0)(-\frac{1}{u_L}) + [f(1)(\frac{-1}{u_H}) - f(0)(-\frac{1}{u_L})](1-\mu_0)] + 1 \\ &> 0. \end{aligned}$$

For $\hat{\mu}$, the participation constraint gives us

$$(1-\hat{\mu})u_H + \hat{\mu}(1-\alpha^*(\hat{\mu}))u_L - t^*(\hat{\mu}) \geq (1-\hat{\mu})u_H + \hat{\mu}(1-\alpha^*(\mu'))u_L - t^*(\mu'), \forall \mu'.$$

Because $\alpha(\hat{\mu}) < 1$, there exists $\mu^\dagger \in (\hat{\mu}, 1)$ such that

$$(1-\mu^\dagger)u_H + \mu^\dagger(1-\alpha^*(\hat{\mu}))u_L - t^*(\hat{\mu}) < 0$$

which implies that $(1-\mu^\dagger)u_H + \mu^\dagger(1-\alpha^*(\mu'))u_L - t^*(\mu') < 0$, $\forall \mu'$. So, $\forall \mu > \mu^\dagger$, $\alpha^*(\mu) = t^*(\mu) = 0$.

Substituting in the utility function into the Sender's profit function,

$$\begin{aligned}
\Pi &= \pi F(\underline{\mu}) + \int_{\underline{\mu}}^{\bar{\mu}} f(\mu)(\pi[(1-\mu_0) + \mu_0(1-\alpha^*(\mu))] \\
&\quad +(1-\mu)u_H + \mu(1-\alpha)u_L - U(\alpha^*, t^*, \mu))d\mu \\
&= \pi F(\underline{\mu}) + \int_{\underline{\mu}}^{\bar{\mu}} f(\mu)(\pi[(1-\mu_0) + \mu_0(1-\alpha(\mu))] \\
&\quad +(1-\mu)u_H + \mu(1-\alpha)u_L - \frac{F(\bar{\mu}) - F(\mu)}{f(\mu)}[-u_H + (1-\alpha^*)u_L])d\mu.
\end{aligned}$$

The pointwise FOC for the profit function yields

$$[-\mu_0\pi - u_L(\mu - \frac{F(\bar{\mu}) - F(\mu)}{f(\mu)})]f(\mu) = 0$$

For most values of μ, the pointwise FOC does not hold, regardless of the choice of α. We can "iron" out the schedule of signals, and rewrite the problem as

$$\begin{aligned}
\max_{\alpha(\mu)} \Pi &= \int_{\underline{\mu}}^{\bar{\mu}} f(\mu)(\pi[(1-\mu_0) + \mu_0(1-\alpha(\mu))] + (1-\mu)u_H \\
&\quad +\mu(1-\alpha)u_L - \frac{F(\bar{\mu}) - F(\mu)}{f(\mu)}[-u_H + (1-\alpha^*)u_L])d\mu
\end{aligned}$$

subject to

$$\begin{aligned}
\frac{d\alpha(\mu)}{d\mu} &= \eta(\mu) \\
\eta(\mu) &\geq 0
\end{aligned}$$

The Hamiltonian of the Sender's problem, fixing $\underline{\mu}$ and $\bar{\mu}$,

$$\begin{aligned}
H(\mu, \alpha, \eta, \lambda) &= f(\mu)(\pi[(1-\mu_0) + \mu_0(1-\alpha(\mu))] \\
&\quad +(1-\mu)u_H + \mu(1-\alpha)u_L - \frac{F(\bar{\mu}) - F(\mu)}{f(\mu)}[-u_H + (1-\alpha^*)u_L]) + \lambda(\mu)\eta(\mu)
\end{aligned}$$

The complementary slackness condition yields

$$\frac{d\alpha^*(\mu)}{d\mu} \cdot \int_{\underline{\mu}}^{\mu} [-\mu_0 \pi - u_L(\mu' - \frac{F(\bar{\mu}) - F(\mu')}{f(\mu')})] f(\mu') d\mu' = 0$$

Notice that for generic $f(\mu)$, $[-\mu_0\pi - u_L(\mu' - \frac{F(\bar{\mu})-F(\mu')}{f(\mu')})]f(\mu') = 0$ at only a finite number of points. This implies that $\frac{d\alpha^*(\mu)}{d\mu} = 0$ except at a finite number of points, so all types are subject to bunching.

Next I show that $\underline{\mu} > 0$. By contradiction, suppose that $\underline{\mu} = 0$. For μ close to zero, notice that $-\mu_0\pi - u_L(\mu - \frac{F(\bar{\mu})-F(\mu)}{f(\mu')}) < 0$. For these μ, the Sender maximizes Π by minimizing $\alpha(\mu)$ until the IR constraint for the pool binds at $\alpha = 0$. But, that violates our assumption that $\underline{\mu} = 0$, so $\underline{\mu}$¿0. □

Proof of Theorem 6. From Corollary 3, I know the threshold Receiver receives a signal with $\alpha > 0$.

I now verify that the Sender does not wish to fully disclose the state for free. Fixing $\alpha = 1$, I examine incentives to increase t.

$$\begin{aligned}
\Pi(\alpha, t) &= \pi[F(\underline{\mu}) + (F(\bar{\mu}) - F(\underline{\mu}))[(1-\mu_0) + \mu_0(1-\alpha))]] \\
\frac{d\Pi(\alpha,t)}{dt}|_{\alpha=1,t=0} &= \pi[f(0)(-\frac{1}{u_L}) + [f(1)(\frac{-1}{u_H}) - f(0)(-\frac{1}{u_L})](1-\mu_0)] \\
&= 0 \\
\frac{d^2\Pi(\alpha,t)}{(dt)^2}|_{\alpha=1,t=0} &= \pi[f'(0)\frac{1}{u_L^2} + [f'(1)\frac{1}{u_H^2} - f'(0)\frac{1}{u_L^2}](1-\mu_0)]
\end{aligned}$$

While $\frac{d\Pi(\alpha,t)}{dt}|_{\alpha=1,t=0} = 0$, notice that $\frac{d^2\Pi(\alpha,t)}{(dt)^2}|_{\alpha=1,t=0}$ can be either positive or negative, depending on the relative magnitudes of $f'(0)$ and $f'(1)$.

Next we must show that that the optimal menu is semi pooled. I take a different approach from the one in Theorem 2. First, I examine the Sender's incentives to provide a separated menu for a small segment of types.

We again examine the relaxed second stage of the following problem. The Sender first choose $\underline{\mu}$ and $\bar{\mu}$, and then chooses $\alpha(\mu)$ subject to the IR and IC constraints.

$$\Pi = \pi F(\underline{\mu}) + \int_{\underline{\mu}}^{\bar{\mu}} f(\mu)(\pi[(1-\mu_0) + \mu_0(1-\alpha^*(\mu))]d\mu$$

In contrast to the transfer setting, the pointwise FOC for the profit function yields

$$[-\mu_0\pi - u_L(\mu - \frac{F(\bar{\mu}) - F(\mu)}{f(\mu)})]f(\mu) = 0$$

For most values of μ, the pointwise FOC does not hold, regardless of the choice of α. Because of this, we must "iron" out the schedule of signals. Rewrite the problem as

$$\begin{aligned} \max_{\alpha(\mu)} \Pi &= \int_{\underline{\mu}}^{\bar{\mu}} f(\mu)(\pi[(1-\mu_0) + \mu_0(1-\alpha(\mu))] + (1-\mu)u_H \\ &\quad + \mu(1-\alpha)u_L - \frac{F(\bar{\mu}) - F(\mu)}{f(\mu)}[-u_H + (1-\alpha^*)u_L])d\mu \end{aligned}$$

subject to

$$\begin{aligned} \frac{d\alpha(\mu)}{d\mu} &= \eta(\mu) \\ \eta(\mu) &\geq 0 \end{aligned}$$

The Hamiltonian of the Sender's problem, fixing $\underline{\mu}$ and $\bar{\mu}$,

$$\begin{aligned} H(\mu, \alpha, \eta, \lambda) &= f(\mu)(\pi[(1-\mu_0) + \mu_0(1-\alpha(\mu))] \\ &\quad + (1-\mu)u_H + \mu(1-\alpha)u_L - \frac{F(\bar{\mu}) - F(\mu)}{f(\mu)}[-u_H + (1-\alpha^*)u_L]) + \lambda(\mu)\eta(\mu) \end{aligned}$$

The complementary slackness condition yields us

$$\frac{d\alpha^*(\mu)}{d\mu} \cdot \int_{\underline{\mu}}^{\mu} [-\mu_0\pi - u_L(\mu' - \frac{F(\bar{\mu}) - F(\mu')}{f(\mu')})]f(\mu')d\mu' = 0$$

Notice that for generic $f(\mu)$, $[-\mu_0\pi - u_L(\mu' - \frac{F(\bar{\mu})-F(\mu')}{f(\mu')})]f(\mu') = 0$ at only a finite number of points. This implies that $\frac{d\alpha^*(\mu)}{d\mu} = 0$ except at a finite number of points, so all types are subject to bunching. □

Proof of Proposition 3. For the first point, it is clear that a menu with $\alpha(\mu) = 1$, $t(\mu, a) = 0$ is still dominated. Therefore, $\bar{\mu} < 1$.

The Sender's problem is to maximize its profit

$$\Pi = \pi F(\underline{\mu}) + \int_{\underline{\mu}}^{\bar{\mu}} f(\mu)(\pi + t(\mu, B))[(1-\mu_0) + \mu_0(1-\alpha^*(\mu))] + \mu_0\alpha(\mu)t(\mu, N)d\mu,$$

subject to the constraints in equations 2.6 to 2.10. I first show that 2.8 implies 2.6.

$$\begin{aligned}(1-\mu)(u_H - t(\mu,B)) + \mu(1-\alpha)(u_L - t(\mu,B)) - \mu\alpha t(\mu,N) &\geq 0\\ (1-\mu)(u_H - t(\mu,B)) + \mu(1-\alpha)(u_L - t(\mu,B)) &\geq \mu\alpha t(\mu,N)\\ (1-\mu)(u_H - t(\mu,B)) + \mu(1-\alpha)(u_L - t(\mu,B)) &\geq -t(\mu,N).\end{aligned}$$

For the other first stage IR constraint, suppose for a Receiver $-t(\mu,N) \geq u_L$. Then for $m = L$, the Receiver would prefer $a = B$, which violates 2.7. Thus2.7 implies 2.9.

Define $\tau_B(\bar{U}, \tau_N, \alpha, \mu)$ such that

$$\begin{aligned}U(\alpha,t,\mu) &= \bar{U}\\ t(\mu,N) &= \tau_N\\ t(\mu,B) &= \tau_B\end{aligned}$$

Notice that for genericα and μ, $\frac{d\tau_B(\bar{U},\tau_N,\alpha,\mu)}{d\tau_N}$ is either strictly greater than $\frac{[(1-\mu_0)+\mu_0(1-\alpha^*(\mu))]}{\mu_0\alpha(\mu)}$, or strictly less than it. If greater than, then the Sender can increase his profit while holding the Receiver's utility for the signal constant by increasing $t(\mu,B)$ and decreasing $t(\mu,N)$ until the nonnegativity constraint binds. If lesser than, then the Sender can decrease $t(\mu,B)$ and increase $t(\mu,N)$. Thus if any mechanism does not have $t(\mu,N) = 0$ or $t(\mu,B) = 0$, it is dominated by one that does. Also, there exists a μ' such that $\frac{d\tau_B(\bar{U},\tau_N,\alpha,\mu)}{d\tau_N} = \frac{[(1-\mu_0)+\mu_0(1-\alpha^*(\mu))]}{\mu_0\alpha(\mu)}$ which forms a cutoff - $\forall\mu < \mu'$, $t(\mu,B) = 0$, and $\forall\mu > \mu'$, $t(\mu,N) = 0$.

The pooling result from the simple transfer setting is show in an analogous manner. The Sender's pointwise FOC does not hold for generic types, thus the entire region must be "ironed". Showing $\underline{\mu} > 0$ is the same in previous settings. □

Appendix C

Proofs for Chapter 3

Proof of Lemma 7 on p. 51. Consider a generic group G, and let $S(c, c^*)$ denote the marginal gain in image when pragmatist voters use cutoff c and the ethical voter has cutoff c^*. Thus,

$$S(c, c^*) = \lambda (\zeta (1, c, c^*) - \zeta (0, c, c^*)).$$

Observe that the first term above is strictly decreasing in c and the second term is strictly increasing in c, and so $S(c, c^*)$ is strictly decreasing in c. Moreover,

$$S(0, c^*) = \lambda \left(1 - \frac{q(1 - F(c^*))}{1 - qF(c^*)}\right) > 0,$$

and $S(c^*, c^*) = 0$. Since S_G is continuous in c, it follows that there exists a unique $\hat{c}_G$ that satisfies Equation 3.3. Applying the Implicit Function Theorem to Equation 3.3 yields that

$$\frac{dP(c^*)}{dc^*} = -\frac{\frac{dS(c,c^*)}{dc^*}}{\frac{dS(c,c^*)}{dc} - 1}$$

which is positive because numerator is strictly positive and the denominator is strictly negative. □

Proof of Theorem 4 on p. 53. Consider the first-order conditions with respect to c_1 and c_2 respectively:

$$\begin{aligned}
\frac{qF(c_2) + (1-q)F(\hat{c}_2)}{(qF(c_1) + (1-q)F(\hat{c}_1))^2} wh\left(\frac{qF(c_2) + (1-q)F(\hat{c}_2)}{qF(c_1) + (1-q)F(\hat{c}_1)}\right) qf(c_1) - \left(\frac{1}{2}\right) c_1 qf(c_1) &= 0, \\
\frac{1}{qF(c_1) + (1-q)F(\hat{c}_1)} wh\left(\frac{qF(c_2) + (1-q)F(\hat{c}_2)}{qF(c_1) + (1-q)F(\hat{c}_1)}\right) qf(c_2) - \left(\frac{1}{2}\right) c_2 qf(c_2) &= 0.
\end{aligned}$$

Comparing the two first-order conditions yields that at an interior solution,

$$\frac{c_1}{c_2} = \frac{qF(c_2) + (1-q)F(\hat{c}_2)}{qF(c_1) + (1-q)F(\hat{c}_1)},$$

which translates into Equation 3.5, from which Equation 3.6 follows. We now verify the second order condition for a maximum. Without loss of generality, we analyze the second-derivative of V_2 at the symmetric solution which is

$$\begin{aligned}
&\frac{w}{qF(c_1^*)+(1-q)F(\hat{c}_1)} q\left[h(1)f'(c_2^*) + f(c_2^*)h'(1)\frac{qf(c_2^*)}{qF(c_1^*)+(1-q)F(\hat{c}_1)}\right] - \tfrac{1}{2}q[f(c_2^*) + c_2^* f'(c_2^*)] \\
&= f'(c_2^*)\left[\frac{w}{qF(c_1^*)+(1-q)F(\hat{c}_1)} qh(1) - \tfrac{1}{2}qc_2^*\right] + f(c_2^*)q\left[\frac{wf(c_2^*)}{(qF(c_1^*)+(1-q)F(\hat{c}_1))^2} h'(1) - \tfrac{1}{2}\right]
\end{aligned}$$

At an interior optimum, the term in the first set of square brackets is equal to $\dfrac{dV_2}{dc_2}$ and so is 0 at the solution to the FOC. It therefore suffices to establish that $h'(1) < 0$, as shown below:

$$\begin{aligned} h'(1) &= \left(-(2\alpha)(\frac{1}{x+1})^{2\alpha+1}\frac{x^{\alpha-1}}{B(\alpha,\alpha)} + (\alpha-1)(\frac{1}{x+1})^{2\alpha}\frac{x^{\alpha-2}}{B(\alpha,\alpha)}\right)\Big|_{x=1} \\ &= -2\alpha\left(\frac{1}{2}\right)^{2\alpha+1}\frac{1}{B(\alpha,\alpha)} + (\alpha-1)(\frac{1}{2})^{2\alpha}\frac{1}{B(\alpha,\alpha)} \\ &= -\frac{1}{2^{2\alpha}B(\alpha,\alpha)} < 0. \end{aligned}$$

□

Proof of Property 4 on p. 53. Since the RHS is increasing in w, it follows that c_G^* is increasing in w for an interior solution. Demonstrating that the RHS is increasing in α is more involved: it suffices to show that $2^{1-2\alpha}/B(\alpha,\alpha)$ is increasing in α. Let Γ be the gamma function: since $B(\alpha,\alpha) = \frac{(\Gamma(\alpha))^2}{\Gamma(2\alpha)}$, we have

$$\begin{aligned} & \frac{2^{1-2\alpha}}{B(\alpha,\alpha)} \\ = & \frac{2^{1-2\alpha}\Gamma(2\alpha)}{(\Gamma(\alpha))^2} \\ = & \frac{1}{\sqrt{\pi}}\frac{\Gamma\left(\alpha+\frac{1}{2}\right)}{\Gamma(\alpha)}, \end{aligned}$$

in which the last equality uses the duplication formula for the gamma function, $\Gamma(z)\Gamma\left(z+\frac{1}{2}\right) = 2^{1-2z}\sqrt{\pi}\Gamma(2z)$.

$$\begin{aligned} & \frac{d}{d\alpha}\left(\frac{1}{\sqrt{\pi}}\frac{\Gamma\left(\alpha+\frac{1}{2}\right)}{\Gamma(\alpha)}\right) \\ = & \frac{\Gamma(\alpha)\Gamma\left(\alpha+\frac{1}{2}\right)\left(\psi\left(\alpha+\frac{1}{2}\right)-\psi(\alpha)\right)}{(\Gamma(\alpha))^2\sqrt{\pi}} \\ = & \frac{2^{1-2\alpha}}{B(\alpha,\alpha)}\left(\psi\left(\alpha+\frac{1}{2}\right)-\psi(\alpha)\right), \end{aligned}$$

where the first equality follows from the quotient rule, and $\frac{d}{d\alpha}\Gamma(\alpha) = \Gamma(\alpha)\psi(\alpha)$, where $\psi(\alpha) = -\gamma + \int_0^1 \frac{1-x^{\alpha-1}}{1-x}dx$ is the digamma function, and γ is the Euler-Mascheroni constant; the second equality follows from above. Since the term outside brackets is strictly positive, it suffices to show that $\psi\left(\alpha+\frac{1}{2}\right)-\psi\left(\alpha\right)\geq 0$:

$$\begin{aligned}
& \psi\left(\alpha+\frac{1}{2}\right)-\psi\left(\alpha\right) \\
= & \int_0^1 \frac{x^{\alpha-1}-x^{\alpha-\frac{1}{2}}}{1-x}dx \\
= & \int_0^1 \frac{x^{\alpha-1}}{1-x}\left(1-x^{1/2}\right)dx \\
> & \ 0.
\end{aligned}$$

Finally, we show that participation increases as the voting costs decrease. Suppose that costs are initially distributed according to cdf F and decrease to cdf $\tilde{F}$. Let c^* and $\tilde{c}$ be the solution to Equation 3.6 with cdf F and $\tilde{F}$ respectively, and let $\hat{c}$ and $\overline{c}$ be the respective cutoff for pragmatists. It follows that

$$c^*\left(qF\left(c^*\right)+\left(1-q\right)F\left(\hat{c}\right)\right)=\tilde{c}\left(q\tilde{F}\left(\tilde{c}\right)+\left(1-q\right)\tilde{F}\left(\overline{c}\right)\right).$$

Given the above equation, it suffices to establish that $c^*\geq\tilde{c}$; suppose otherwise towards a contradiction. Because F strictly first-order stochastically dominates $\tilde{F}$, it follows that $\tilde{F}(\tilde{c})>F(\tilde{c})>F(c^*)$. From the signaling incentives, it follows that $\tilde{F}(\overline{c})>F(\hat{c})$: otherwise, $\overline{c}<\hat{c}$, and so a pragmatist at cost $\hat{c}$ is not willing to vote when costs are distributed according $\tilde{F}$ despite the stronger social incentive to vote. The equation above however is false if $\tilde{F}(\tilde{c})>F(c^*)$ and $\tilde{F}(\overline{c}>F(\hat{c})$ leading to a contradiction. □

Proof of Property 5 on p. 54. Applying the Implicit Function Theorem to Equation 3.3 yields that

$$\frac{dP}{d\lambda}=-\frac{\zeta\left(1,P\left(c^*\right),c^*\right)-\zeta\left(0,P\left(c^*\right),c^*\right)+\frac{dS(P(c^*),c^*)}{dc^*}\frac{dc^*}{d\lambda}}{\frac{dS(c,c^*)}{dc}-1}$$

From the above expression, it follows that $dc^*/d\lambda>0$ implies $d\hat{c}_G/d\lambda>0$. Yet, if c^* increases with λ, then the entire term on the LHS of Equation 3.6 increases, resulting in a contradiction. Therefore, c_G^* must decrease with λ, and to satisfy Equation 3.6 , it follows that $qF(c_G^*)+(1-q)F(P(c_G^*)$ is increasing in λ: therefore, both the overall participation rate and that of pragmatists increases with λ. □

Proof of Property 6 on p. 54. By Equation 3.3, $\hat{c}_G > 0$ if and only if $S(\hat{c}_G, c_G^*) > 0$, which is true if and only if $F_G(\hat{c}_G) < F_G(c_G^*)$. $\square$

Proof of Property 7 on p. 55. Consider a sequence $\{q_n\}_{n=1}^{\infty}$ such that $q_n \to 0$, and the corresponding cutoffs for ethical and pragmatic citizens $\left\{c_{G,n}^*, \hat{c}_{G,n}\right\}_{n=1}^{\infty}$; for each n, these cutoffs must satisfy *Equation* 3.6. Observe that

$$q_n F\left(c_{G,n}^*\right) + (1 - q_n) F\left(\hat{c}_{G,n}\right) \to (1 - q_n) F\left(\hat{c}_{G,n}\right),$$

and so to prove that aggregate turnout is vanishing, it suffices to establish that $\hat{c}_{G,n} \to 0$. From Equation 3.3, it follows that

$$\hat{c}_{G,n} F\left(\hat{c}_{G,n}\right) < \frac{\lambda q_n}{1 - q_n},$$

and therefore, $\lim_{q_n \to 0} \hat{c}_{G,n} = 0$.

Equation 3.6 is satisfied only if $c_{G,n}^* \to \infty$ which implies that $F\left(c_{G,n}^*\right) \to 1$. $\square$

Proof of Property 8 on p. 56. Suppose that $w_2 > w_1$; Equation C.2 fails if $c_2^* \leq c_1^*$ because $T_1 = T_2$ and is increasing in its argument. Therefore $c_2^* > c_1^*$ and $\hat{c}_2 = P(c_2^*) > P(c_1^*) = \hat{c}_1$. The argument for when costs are asymmetric and F_1 strictly first order stochastically dominates F_2 is identical to that in Property 4 substituting F_1 for F and F_2 for $\tilde{F}$. $\square$

Proof of Property 9 on p. 56. It follows from Property 5 that $P_2(c) > P_1(c)$ for every c. Equation C.2 in the Supplementary Appendix holds if and only if $c_1^* > c_2^*$, which implies that $T_1(c_1^*) < T_2(c_2^*)$. $\square$

C.1 Supplementary Appendix (For Online Publication)

C.1.1 Unique Equilibrium with Asymmetric Groups

Before proving the results in the paper, we first establish that a unique political equilibrium exists even when groups are asymmetric if k is uniform on $[0,1]$. For group G, we denote by w_G the importance of the election for members of group G, by F_G the distribution of their voting costs, and by λ_G the strength of social incentives. Let P_G denote the Pragmatist Best Response for group G, and for a cost c_G, let $T_G(c) = qF_G(c) + (1-q)F_G(P_G(c))$ denote the total turnout from group G; it follows that T_G is increasing in c. The first-order conditions are

$$\begin{aligned} \frac{T_2(c_2)}{\left(T_1\left(c_1\right)\right)^2} w_1 h\left(\frac{T_2(c_2)}{T_1\left(c_1\right)}\right) &= \frac{c_1}{2}, \\ \frac{1}{T_1\left(c_1\right)} w_2 h\left(\frac{T_2(c_2)}{T_1\left(c_1\right)}\right) &= \frac{c_2}{2}. \end{aligned} \tag{C.1}$$

Therefore,

$$\frac{c_1 T_1\left(c_1\right)}{w_1} = \frac{c_2 T_2(c_2)}{w_2}. \tag{C.2}$$

For the claims that follow, we assume that k is uniformly distributed on $[0,1]$; the two claims together imply existence and uniqueness of political equilibrium.

Claim 1. (c_1, c_2) *that satisfy the first-order conditions in Equation C.1 are maxima.*

Proof. As in the proof of Theorem 4, it suffices to establish that $h'\left(\frac{T_2(c_2)}{T_1(c_1)}\right) < 0$, which is necessarily true when $\alpha = 1$ since $h'(x) = -\frac{2}{(x+1)^3} < 0$ for all x. □

Claim 2. *There is a unique solution to Equation C.1.*

Proof. Our argument adapts the proof of Fact 1 on p. 22-23 of Feddersen and Sandroni (2006*c*) to our environment. Suppose that there were two solutions c_1, c_2 and c_1', c_2'. It follows from Equation C.2 that if $c_1' > (=,<) c_1$, then $c_2' > (=,<) c_2$, and so WLOG, we assume that $c_1' > c_1$. Let $\tau = \frac{T_2(c_2)}{T_1(c_1)}$ and $\tau' = \frac{T_2(c_2')}{T_1\left(c_1'\right)}$. It follows from Equation C.2 that

$$sgn\left(\tau' - \tau\right) = sgn\left(\frac{c_1'}{c_2'} - \frac{c_1}{c_2}\right).$$

We study two complementary cases below and show how each yields a contradiction.

1. $\frac{c_1'}{c_2'} \geq \frac{c_1}{c_2}$: Re-writing the second equation in Equation C.1 yields that

   $$c_2' T_1(c_1') = 2w_2 h(\tau') \leq 2w_2 h(\tau) = c_2 T_1(c_1),$$

   in which the inequality follows h being a decreasing function if $\alpha = 1$ and $\tau' \geq \tau$. Since T_1 is a strictly increasing function, the above equation contradicts $(c_1', c_2') >> (c_1, c_2)$.

2. $\frac{c_1'}{c_2'} < \frac{c_1}{c_2}$: Analogous to h, consider the density function of $\frac{1-k}{k}$ denoted by $\tilde{h}$. It follows that the first equation of Equation C.1 can be re-written as

   $$\frac{1}{T_2\left(c_2\right)} w_1 \tilde{h}\left(\frac{1}{\tau}\right) = \frac{c_1}{2}. \tag{C.3}$$

   Since $\tilde{h}$ is decreasing in its argument, and $\tau' < \tau$, it follows that

   $$c_1' T_2(c_2') = 2w_1 h(\frac{1}{\tau'}) < 2w_1 h(\frac{1}{\tau}) = c_1 T_2(c_2),$$

   which contradicts $(c_1', c_2') >> (c_1, c_2)$.

□

C.1.2 Proofs for Section 3.3

Proof of Theorem 5 on p. 59. We begin by establishing that the Pragmatist Best Response is unique. For $P\left(c^*\right)$ as defined in Definition 1, and for arbitrary c^*, consider

$$(1-s)\zeta\left(1, P\left(c^*\right), c^*\right) - \zeta\left(0, P\left(c^*\right), c^*\right).$$

The term above is continuously decreasing in s, is strictly positive when $s = 0$, and strictly negative when $s = 1$. Let $\overline{s}(c^*)$ be the unique value of s such that the term above is 0.

First, suppose that $s \geq \overline{s}(c^*)$: we claim that the unique Pragmatist Best Response in this setting is identical to $P(c^*)$ (of Definition 1) and with $\mu_G = 0$. Notice that the Truthful Abstainer's Image is at least as large as the Lying Abstainer's Image, and therefore, no pragmatist has an incentive to deviate. Suppose that there was another pragmatist response in which $\mu_G > 0$ and the pragmatist's cost cutoff is $\tilde{c}$. To satisfy (4) of Definition 4, it follows that $F(\tilde{c}) + \mu_G \leq F(P(c^*))$. Because a pragmatist with cost $\tilde{c}$ is indifferent between voting and not,

$$\begin{aligned}\tilde{c} &= \lambda \left(\begin{array}{l} s\dfrac{qF(c^*)}{qF(c^*) + (1-q)F(\tilde{c})} + (1-s)\dfrac{qF(c^*)}{qF(c^*) + (1-q)(F(\tilde{c}) + \mu_G)} \\ -\dfrac{q(1-F(c^*))}{q(1-F(c^*)) + (1-q)(1-F(\tilde{c}) - \mu_G)} \end{array} \right) \\ &\geq \lambda\left(\zeta\left(1, P(c^*), c^*\right) - \zeta\left(0, P(c^*), c^*\right)\right) \\ &= P(c^*),\end{aligned}$$

which is a contradiction.

Now, suppose that $s < \overline{s}(c^*)$: for all $s \leq \overline{s}(c^*)$, find the unique cost, $c(s, c^*)$, that makes a voter indifferent between voting and obtaining the Voter's Image, and abstention-lying obtaining the Lying Abstainer's Image when ethical citizens use a cutoff of c^*. It follows that

$$c(s, c^*) = \lambda s \frac{qF(c^*)}{qF(c^*) + (1-q)F(c(s, c^*))}.$$

For the equality to hold, $c(s, c^*)$ is increasing in s, and by construction, $c(\overline{s}(c^*), c^*) = P(c^*)$. Therefore, for $s < \overline{s}(c^*)$, $c(s, c^*) < P(c^*)$. Setting $\tilde{c}_G = c(s, c^*)$ consider the expression given by Lying Abstainer's Image $-$ Truthful Abstainer's Image: it is continuously decreasing in μ_G and strictly negative at $\mu_G = 1 - F(\tilde{c}_G)$. Moreover, at $\mu_G = 0$, the term is

$$
\begin{aligned}
&(1-s)\zeta\left(1, c(s,c^*), c^*\right) - \zeta\left(0, c(s,c^*), c^*\right) \\
>&(1-\overline{s}(c^*))\zeta\left(1, c(s,c^*), c^*\right) - \zeta\left(0, c(s,c^*), c^*\right) \\
>&(1-\overline{s}(c^*))\zeta\left(1, P\left(c^*\right), c^*\right) - \zeta\left(0, P\left(c^*\right), c^*\right) \\
=&0,
\end{aligned}
$$

in which the first inequality follows from $s < \overline{s}(c^*)$, the second inequality follows from $c(s, c^*) < P(c^*)$, and the equality is by construction. Therefore, there exists a unique μ_G that equates Lying Abstainer's Image and Truthful Abstainer's Image.

Thus, we have constructed the unique Pragmatist Best Response in the model that permits lying. Based on the above discussion, we extend $c(s, c^*)$ to the entire domain $[0, 1] \times [0, \infty)$; since signaling incentives are increasing in c^*, it follows that $c(s, c^*)$ is increasing in c^*. The first-order condition generated by the Consistent Ethical Rule is similar to that in Theorem 4, and yields an analogue to Equation 3.5:

$$
c_1^*\left(qF\left(c_1^*\right) + (1-q)\,F\left(c(s,c_1^*)\right)\right) = c_2^*\left(qF(c_2^*) + (1-q)F\left(c(s,c_2^*)\right)\right).
$$

Since $c(s, c^*)$ is increasing in c^*, it follows that $c_1^* = c_2^*$, from which the characterization Theorem 5 follows.

Consider the ethical cutoff from the unique political equilibrium in Theorem 4 and denote this by C. Let $\tilde{s} = \overline{s}(C)$. It follows that if $s \geq \tilde{s}$, the unique equilibrium corresponds to Theorem 4. On the other hand, if $s < \tilde{s}$, then the unique equilibrium involves $\mu_G > 0$, and a pragmatist participation less than that in the setting without lying $c(s, c^*) < P(C)$. As s increases, $c(s, c^*)$ increases and so it follows that c_G^* decreases for each group G while overall turnout increases. □

Proof of Theorem 6 on p. 61. We first establish the existence and uniqueness of a pragmatic best response. Holding fixed an ethical participation rate μ^*, notice that $\zeta\left(1, c, \mu^c, \mu, \mu^*\right)$ is strictly decreasing in μ^c and $\hat{\mu}$ and $\zeta\left(0, c, \mu, \mu^*\right)$ is strictly increasing in $\hat{\mu}$. For each c, and for each $\mu \in [0, 1]$, let $h^c\left(\mu, \mu^*\right)$ define the participation rate among pragmatists with cost c when the participation rates among all pragmatists and ethical citizens in group G are μ and μ^* respectively. Formally, for $c \leq c^*$, $h^c = 1$ if $c \leq \lambda(\zeta(1, c, 1, \mu, \mu^*) - \zeta(0, c, \mu, \mu^*))$, $h^c = 0$ if $c > \lambda(\zeta(1, c, 0, \mu, \mu^*) - \zeta(0, c, \mu, \mu^*))$, and otherwise,

$$h^c(\mu, \mu^*) = \left[(c/\lambda + \zeta(0, c, \mu, \mu^*) - \zeta(0, c, 1-\mu, 1-\mu^*))^{-1} pq - q\right]/(1-q).$$

In essence, h^c is 1 (resp. 0) if a citizen with cost c is better off voting (resp. abstaining) even when it is known that all citizens with that cost vote (resp. abstain). Otherwise, h^c finds the randomization probability that makes a voter with cost c indifferent. It follows that h^c is weakly decreasing and continuous in μ.

For $\mu \in [0, 1]$, let $h(\mu, \mu^*) = \int_0^{\bar{c}} h^c(\mu, \mu^*)\, dF$. Since $h(\mu, \mu^*) \in [0, 1]$, and h is continuous and weakly decreasing in μ, it follows that there exists a unique μ that satisfies $\mu = h(\mu, \mu^*)$. This is the unique Pragmatist Best Response. The remainder of the argument for existence and uniqueness follows Theorem 4. □

Proofs for Section 3.3.3

Before establishing results for this setting, we extend our definitions of Consistent Ethical Response; since we impose stable responses from pragmatists, it is without loss of generality and more convenient to treat $\hat{c}_1 = \hat{c}_2$ throughout. The social cost of voting is

$$\phi(\rho_1, \rho_2, c_1, c_2, \hat{c}) = \left(\frac{q}{2}\right)\left(\int_0^{c_1} c dF + \int_0^{c_2} c dF\right) + (1-q)\left(\int_0^{\hat{c}} c dF\right).$$

The aggregate welfare as perceived by ethical citizens in each group is

$$V_1(\rho_1, \rho_2, c_1, c_2, \hat{c}) = w_1\left(1 - H\left(\frac{qF(c_2) + (1-q)\int_0^{\hat{c}} \rho_2(c) dF}{qF(c_1) + (1-q)\int_0^{\hat{c}} \rho_1(c) dF}\right)\right) - \phi(\rho_1, \rho_2, c_1, c_2, \hat{c}),$$

$$V_2(\rho_1, \rho_2, c_1, c_2, \hat{c}, \hat{c}) = w_2 H\left(\frac{qF(c_2) + (1-q)\int_0^{\hat{c}} \rho_2(c) dF}{qF(c_1) + (1-q)\int_0^{\hat{c}} \rho_1(c) dF}\right) - \phi(\rho_1, \rho_2, c_1, c_2, \hat{c}).$$

Definition 8. *A profile (c_1^*, c_2^*) is a* ***Consistent Ethical Response*** *to $(\rho_1, \rho_2, \hat{c})$ if for every group G,*

$$V_G\left(\rho_1, \rho_2, c_G^*, c_{-G}^*, \hat{c}\right) \geq V_G\left(\rho_1, \rho_2, c, c_{-G}^*, \hat{c}\right) \text{ for all } c > 0.$$

Proof of Theorem 7. We establish existence and uniqueness using the steps outlined in the text. First, we define a simpler class of FEPE that suffices for analysis.

Definition 9. *An FEPE* $\left\{ (\rho_1, \rho_2, \hat{c}), (c_1^*, c_2^*) \right\}$ *is* simple *if* $\rho_1(c) = \underline{r}\mathbf{1}_{c \leq \hat{c}} + \overline{r}\mathbf{1}_{c > \hat{c}}$ *for some* $\underline{r}, \overline{r} \in [0, 1]$.[1]

Simple FEPE appears to be a restriction of FEPE; the first step of our proof is to show that this restriction is without loss of generality.

Step 1: *Every FEPE can be translated to a simple FEPE.*

Consider an FEPE of the form $\left\{ (\rho_1, \rho_2, \hat{c}), (c_1^*, c_2^*) \right\}$. Define

$$\underline{r} = \frac{\int_0^{\hat{c}} \rho_1(c) dF}{F(\hat{c})}, \overline{r} = \frac{\int_{\hat{c}}^{\infty} \rho_1(c) dF}{1 - F(\hat{c})}.$$

Notice that if one changes $\rho_1(c)$ to $\rho_1'(c) = \underline{r}\mathbf{1}_{c \leq \hat{c}_1} + \overline{r}\mathbf{1}_{c > \hat{c}_1}$, and $\rho_2(c)$ to $\rho_2'(c) = 1 - \rho_1(c)$, the incentives for pragmatists and ethical citizens remain unchanged. So this is also an FEPE and is payoff and outcome equivalent to the original FEPE. Based on this step, we restrict attention to these simple pragmatic choices encoded by $(\hat{c}, \underline{r}, \overline{r})$.

Step 2: *For each* (c_1^*, c_2^*)*, there exists a unique Simple Stable Response* $(\hat{c}, \underline{r}, \overline{r})$*.*

Define

$$\underline{r}(c_1^*, c_2^*, c) \equiv_{r \in [0,1]} \left| \frac{\lambda_1 q F(c_1^*)}{q F(c_1^*) + (1-q) r F(c)} - \frac{\lambda_2 q F(c_2^*)}{q F(c_2^*) + (1-q)(1-r) F(c)} \right|.$$

Since the term in $|\cdot|$ is strictly decreasing in r, it follows that $\underline{r}(c_1^*, c_2^*, c)$ is single-valued and can be treated as a function of c for $c > 0$. Similarly, define $\overline{r}(c_1^*, c_2^*, c)$ as

$$_{r \in [0,1]} \left| \frac{\lambda_1 q \left(1 - F(c_1^*)\right)}{q \left(1 - F(c_1^*)\right) + (1-q) r \left(1 - F(c)\right)} - \frac{\lambda_2 q \left(1 - F(c_1^*)\right)}{q \left(1 - F(c_1^*)\right) + (1-q)(1-r) \left(1 - F(c)\right)} \right|,$$

which also is single-valued.

For every c, set ρ_1 to $\underline{r}(c_1^*, c_2^*, c)\mathbf{1}_{c \leq c} + \overline{r}(c_1^*, c_2^*, c)\mathbf{1}_{c > c}$ and define $\tilde{\zeta}(c_1^*, c_2^*, c)$ as

$$\tilde{\zeta}(c_1^*, c_2^*, c) = \max_{G \in \{1,2\}} \lambda_G \zeta\left(1, \rho_G, c, c_G^*\right) - \max_{G' \in \{1,2\}} \lambda_{G'} \zeta\left(0, \rho_{G'}, c, c_{G'}^*\right).$$

[1]By Feasibility, an analogous condition is trivially satisfied for group 2.

We show that $\max_{G\in\{1,2\}} \lambda_G \zeta\left(1, \rho_G, c, c_G^*\right)$ is decreasing in c.

Case 1: Suppose that $\underline{r}(c_1^*, c_2^*, c) \in (0,1)$. Then,

$$\max_{G\in\{1,2\}} \lambda_G \zeta\left(1, \rho_G, c, c_G^*\right) = \frac{\lambda_1 q F(c_1^*)}{qF(c_1^*) + (1-q)\underline{r}(c_1^*, c_2^*, c)F(c)} = \frac{\lambda_2 q F(c_2^*)}{qF(c_2^*) + (1-q)(1-\underline{r}(c_1^*, c_2^*, c))F(c)}.$$

For a small increase in c, the equality is still satisfied but both terms cannot (weakly) increase with c, and therefore, $\max_{G\in\{1,2\}} \lambda_G \zeta\left(1, \rho_G, c, c_G^*\right)$ strictly decreases (locally) in c at this range.

Case 2: Suppose that $\underline{r}(c_1^*, c_2^*, c) = 1$. Then,

$$\max_{G\in\{1,2\}} \lambda_G \zeta\left(1, \rho_G, c, c_G^*\right) = \frac{\lambda_1 q F(c_1^*)}{qF(c_1^*) + (1-q)F(c)} \geq \lambda_2.$$

For a small increase in c to $c+\epsilon$, regardless of whether $\underline{r}(c_1^*, c_2^*, c+\epsilon) = 1$ or $\underline{r}(c_1^*, c_2^*, c) < 1$, it follows that $\max_{G\in\{1,2\}} \lambda_G \zeta\left(1, \rho_G, c, c_G^*\right) > \max_{G\in\{1,2\}} \lambda_G \zeta\left(1, \rho_G, c+\epsilon, c_G^*\right)$.

Case 3: Suppose that $\underline{r}(c_1^*, c_2^*, c) = 0$. The analysis is similar to Case 2.

A similar argument establishes that $\max_{G'\in\{1,2\}} \lambda_{G'} \zeta\left(0, \rho_{G'}, c, c_{G'}^*\right)$ is increasing in c, and therefore, $\tilde{\zeta}(c_1^*, c_2^*, c)$ is decreasing in c. Clearly $\tilde{\zeta}(c_1^*, c_2^*, 0) > 0$ and $\tilde{\zeta}(c_1^*, c_2^*, c) < 0$ for $c > c_1^*, c_2^*$. Therefore, there exists a unique c that satisfies (3.13). This characterizes the unique Simple Stable Response.

We use this to establish that there is a unique simple FEPE. For a pair of ethical cutoffs (c_1, c_2), let $T_G(c_1, c_2)$ be the expected turnout of members in group G, accounting for the unique Simple Stable Response:

$$T_G(c_1^*, c_2^*) = qF(c_G^*) + (1-q)\int_0^{\hat{c}} \rho_G(c)dF. \tag{C.4}$$

Using arguments similar to those in the proof of Property 5, one can show that T_G is increasing in both arguments. It follows that at an interior solution,

$$\frac{c_1 T_1\left(c_1, c_2\right)}{w_1} = \frac{c_2 T_2(c_1, c_2)}{w_2}. \tag{C.5}$$

Arguments similar to Section C.1.1 establish that this corresponds to a maximum and has a unique solution. □

Proof of Property 10 on p. 67. Notice that for $\lambda_1 = \lambda_2$, then $T_1(c,c) = T_2(c,c)$. Therefore, because $c_1^* > c_2^*$ implies a higher $F(c_1^*)$ and $F(\hat{c})$, $T_1(c_1^*, c_2^*) - T_2(c_1^*, c_2^*)$

has the same sign as $c_1^* - c_2^*$. By (C.5), it follows that if $w_2 > w_1$, then $c_2^* > c_1^*$, and therefore, $T_2(c_1^*, c_2^*) > T_1(c_1^*, c_2^*)$. So Group 2 has a greater probability of victory. Finally, if $\underline{r}(c_1^*, c_2^*, \hat{c}) \geq \frac{1}{2}$, then every Pragmatic voter is strictly better off by joining group 2, which contradicts stability. □

Proof of Property 11 on p. 67. With $\lambda_1 < \lambda_2$, it follows that $\underline{r}(c, c, \tilde{c}) \leq \frac{1}{2}$ for every c and $\tilde{c}$. Therefore, $T_1(c, c) < T_2(c, c)$. To satisfy (C.5), it follows that $c_2^* < c_1^*$. Thus, $T_2(c_1^*, c_2^*) > T_1(c_1^*, c_2^*)$, from which it follows that $\underline{r}(c_1^*, c_2^*, \hat{c}) \leq \frac{1}{2}$. □

C.1.3 Proofs for Section 3.4

Proof of Theorem 8 on p. 69. We first establish that $\frac{3}{2} - x$ is not an equilibrium platform because it is defeated by each of the other platforms with probability greater than 1/2:

$$\frac{1}{\kappa\kappa_x} = \frac{w_1\left(\frac{3}{2}, \frac{3}{2} - x\right)}{w_2\left(\frac{3}{2}, \frac{3}{2} - x\right)} < \frac{w_1\left(\frac{3}{2} + x, \frac{3}{2} - x\right)}{w_2\left(\frac{3}{2} + x, \frac{3}{2} - x\right)} = \frac{1}{\kappa} \leq 1.$$

Therefore, by Property 8, $\frac{3}{2} - x$ is defeated by each of the other platform with probability strictly greater than $\frac{1}{2}$ if $\kappa > 1$, and by Property 9 if $\kappa = 1$ and $\lambda_2 > \lambda_1$.

When responsiveness is asymmetric, $\frac{3}{2}$ defeats (resp. is defeated by) $\frac{3}{2} + x$ if $\kappa <$ (resp. $>$)κ_x with probability exceeding $\frac{1}{2}$, yielding the unique equilibrium prediction. When social incentives are asymmetric, notice that if $\kappa_x = 1$ then by Property 9 it follows that $\lambda_2 > \lambda_1$ implies that $\frac{3}{2} + x$ defeats $\frac{3}{2}$ with probability exceeding $\frac{1}{2}$. Therefore, the desired result follows by continuity.

□

Proof of Theorem 9 on p. 70. For proposals (p_1, p_2), let $\Pi(p_1, p_2)$ denote the probability with which candidate 1 wins. Candidate G's payoff therefore is:

$$\Pi(p_1, p_2)v\left(|p_1 - G|\right) + \left(1 - \Pi(p_1, p_2)\right)v\left(|p_2 - G|\right).$$

Since $\Pi(p_1, p_2) \in (0, 1)$ for every (p_1, p_2), it follows that in every pure strategy equilibrium, candidates run on different platforms. Moreover, notice that if $(p_1, p_2) = \left(\frac{3}{2} - x, \frac{3}{2} + x\right)$, then Candidate 2 wins with probability of at least $\frac{1}{2}$, and therefore, $\left(\frac{3}{2}, \frac{3}{2} + x\right)$ is not an equilibrium. When responsiveness is asymmetric, then the unique equilibrium platform is $\left(\frac{3}{2}, \frac{3}{2} + x\right)$ if $v_x = 1$ and $\kappa > \kappa_x$, and therefore the result follows by continuity. When social incentives are asymmetric, then the unique equilibrium platform is $\left(\frac{3}{2}, \frac{3}{2} + x\right)$ if $v_x = 1$, $\kappa_x = 1$ and $\lambda_2 > \lambda$, and therefore the result follows by continuity. □

C.1.4 Naïve Ethics

The naïve ethical determines behavior as if all citizens are ethical, and therefore (incorrectly) deems the social cost of voting to be

$$\phi^N(c_1, c_2) = E[k] \int_0^{c_1} cdF + (1 - E[k]) \int_0^{c_2} cdF.$$

The aggregate welfare as perceived by group 1 (that for group 2 is analogous) is

$$V_1^N(c_1, c_2) = w\left(1 - H\left(\frac{F(c_2)}{F(c_1)}\right)\right) - \phi(c_1, c_2). \tag{C.6}$$

Definition 10. *A profile $\left(c_1^N, c_2^N\right)$ is a* ***Naïve Ethical Rule*** *if for every group G,*

$$V_G^N\left(c_G^N, c_{-G}^N\right) \geq V_G^N\left(c, c_{-G}^N\right) \text{ for all } c > 0.$$

In contrast to Definition 2, Naïve Ethical Rules are not "best-responses" to the behavior of pragmatists but to the ethical rule of the opposing group. A naïve political equilibrium then is simply a profile of thresholds $\left\{\left(c_G^N, \hat{c}_G\right)_{G=1,2}\right\}$ such that (c_1^N, c_2^N) are Naïve Ethical Rules, and $\hat{c}_G = P(c_G^N)$. Analogous to Theorem 4, it is straightforward to show that the following holds.

Theorem 11. *There is a unique naïve political equilibrium: for every group G, c_G^N solves*

$$cF(c) = \frac{2^{1-2\alpha}w}{B(\alpha, \alpha)}. \tag{C.7}$$

By comparison to the political equilibrium described in Section 3.2.3, the naïve political equilibrium necessarily has a lower participation rate among ethical citizens and pragmatists because ethical citizens do not compensate for the lower participation of pragmatists. It is straightforward to show that Properties 4 and 6 apply; because naïve ethical citizens do not respond to pragmatists, only those parts of Properties 5 and 9 regarding average participation continue to hold.

C.1.5 Continuum of Types

Given an ethical rule, let $R_G(a_i, c_i)$ be a binary indicator that is 1 if and only if the action a_i is ethical when the cost of voting is c_i. Each citizen privately knows how much she values following the ethical rule; her *ethical coefficient* D_i scales her private gain from behaving ethically and is drawn from the interval $[0, \infty)$ with a smooth cdf F^E, independent of her voting cost; as before, the individual's voting cost c_i is drawn from $[0, \infty)$. Within this setting, a citizen i is ethical if $D_i > c_i$ since she is willing to vote or abstain as required by the ethical rule.[2]

When an agent i belongs to group G, her payoff from taking action a_i is

$$-c_i a_i + D_i R_G(a_i, c_i) + \lambda \Pr(D_i \geq c_i | a_i). \tag{C.8}$$

This formulation encapsulates intrinsic motivation towards ethics, as captured by D_i, and the extrinsic motivation to appear to be a member of this ethical group, as captured by λ.

Figure C.1 describes voting behavior in this context. One can partition the citizens types (D_i, c_i) into three categories: those who abstain, those who vote because of social incentives, and ethical citizens who vote absent social incentives. The vertical line at c_G^* represents the cost cutoff from the ethical rule, and the 45 degree line through the origin separates the citizens in the latter two categories. The gap between the two 45 degree lines illustrates the extrinsic motives for voting, and all other types abstain. As in the binary types model, no citizen with costs above the ethical cut-off chooses to vote.

[2]Were voting costs to have an upper-bound, $\bar{c}$, a simpler definition of an ethical citizen would be one for whom $D_i > \bar{c}$. To maintain consistency with the rest of the paper, we model costs as being unbounded.

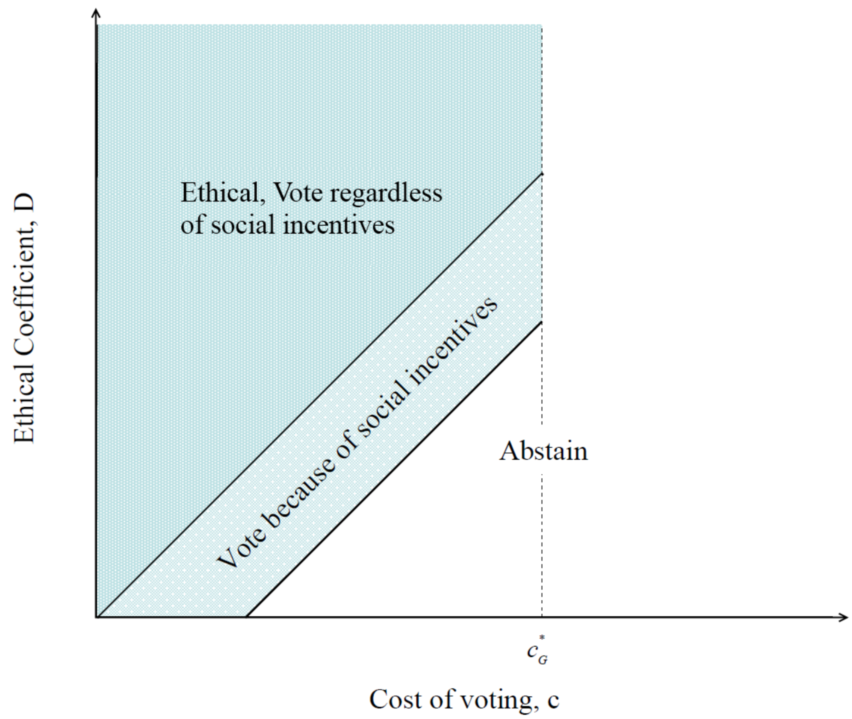

Figure C.1: Voting behavior with a continuum of types

Theorem 12. *There exists a unique political equilibrium.*

Proof. First, we show that there exists a unique Pragmatic Best Response given any ethical rule c^*_G. Fix a given c^*_G, and for a fixed S, consider the sets of types:

$$\Gamma_S = \Big\{ (D_i, c_i) : D_i \left(R_G\left(1, c_i\right) - R_G\left(0, c_i\right)\right) + S \geq c_i \Big\},$$
$$\tilde{\Gamma}_S = \Re^2_+ \backslash \Gamma_S.$$

The sets above consider those types that vote (resp. abstain) when the extrinsic incentive corresponds to S. Let

$$\iota\left(S\right) = \lambda \left(\Pr\left[D_i \geq c_i | \Gamma_S\right] - \Pr\left[D_i \geq c_i | \tilde{\Gamma}_S\right] \right)$$

denote the payoff gap induced from social esteem between voters and abstainers when it is believed that only types in Γ_S vote. A Pragmatist Best Response satisfies $\iota\left(S\right) = S$.

Towards showing that a Pragmatist Best Response exists, observe that $\iota(0) > 0$: Γ_0 comprises types above the 45 degree line in Figure C.1, and therefore, $\Pr[D_i \geq c_i | \Gamma_0] = 1$. In contrast, $\tilde{\Gamma}_0$ comprises types below the 45 for costs below c_G^*, and therefore, $\Pr\left[D_i \geq c_i | \tilde{\Gamma}_0\right] < 1$. Now, observe that $\iota(c_G^*) \leq 0$: $\Gamma_{c_G^*}$ comprises all types for which $c_i \leq c_G^*$, and $\tilde{\Gamma}_{c_G^*}$ comprises all types for which $c_i > c_G^*$. Because $\Pr[D_i \geq c_i | c_i]$ is decreasing in c_i, it follows that $i(c_G^*) \leq 0$. Finally, we note that $\iota(S)$ is strictly decreasing in S. Let $S^\dagger > S$. Observe that $\Pr[D_i \geq \bar{c} | \Gamma_{S^\dagger}] \leq \Pr[D_i \geq \bar{c} | \Gamma_S]$, and $\Pr\left[D_i \geq \bar{c} | \tilde{\Gamma}_{S^\dagger}\right] \geq \Pr\left[D_i \geq \bar{c} | \tilde{\Gamma}_S\right]$ from which it follows that $\iota(S^\dagger) \leq \iota(S)$. Therefore, the Pragmatic Best Response exists and is unique. It is straightforward to show that the participation rate of pragmatists is increasing in c_G^*.

We turn to proving existence and uniqueness of the Consistent Ethical Response. Let $Q(c)$ denote the fraction of citizens in group G who participate when the ethical cutoff is c; it follows that $Q(c)$ is increasing in c. By reasoning analogous to Theorem 4, it follows that in a political equilibrium,

$$c_1 Q(c_1) = c_2 Q(c_2),$$

which as before implies that the political equilibrium exists, and the associated ethical cutoff solves $cQ(c) = 2^{1-2\alpha} w / B(\alpha, \alpha)$. □

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